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UNIVERZITY KARLOVY

SELECTED CHAPTERS IN ORTHOPEDICS AND TRAUMATOLOGY FOR MEDICAL STUDENTS

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PREFACE

In 2021, with the support of the publishing house Karolinum, we were able to publish a textbook tailor made for the students of the Third Faculty of Medicine of Charles University. The textbook is divided according to the 38 questions each student of the faculty needs to master in order to successfully pass the final State Exam from Surgery – subsection Orthopedics and Traumatology. With the help of our graduate Dushan Michael Kolesár we were able to create an English version of our textbook. Dushan deserves endless thanks for the time and work he devoted to the translation of the Czech texts into English.

The text contains basic information, from which we base our questions during the State Exam. It does not however mean that this textbook should be the only source of information during your studies for the State Exam from Surgery (other recommended literature can be found in the list of Recommended and cited literature at the end of each chapter). This text should be seen as a guide on how to formulate each individual answer to a specific question, in order to help the student to properly structure his/her answer and contain all the basic information in order to successfully pass. We will be happy if this textbook becomes an aid to English curriculum students of other medical faculties our university and other universities around the Czech Republic and Slovakia.

We would like to remind that this textbook is based on previous texts which we created for our students, and which was only available in electronic form (the editors of our first version 1999 were Jan Bartoníček and Valér Džupa, the editors of our second version 2010 were Martin Krbec and Valér Džupa). In current edition, the texts have been significantly modified and supplemented when compared to their previous ones, also we have added chapters regarding pediatric traumatology of the musculoskeletal system.

We would like to further thank our reviewers Jana Chmelová, Tomáš Pavelka, and Pavel Šponer for their inspiring comments, which helped us to improve the comprehensibility of our text, and remove any ambiguities.

We would also like to thank Klára Marešová for drawing pictures and schemes used in this book.

Images used in this text were gained through diagnostic methods and treatment of patients. Most radio-diagnostic images were created at the Department of Radiology of the Third Faculty of Medicine of Charles University and the University Hospital Královské Vinohrady, the Department of Radiology of the Thomayer University Hospital and the Department of Radiology of the Bulovka University Hospital. We would like to thank all the employees of these centers for their perfect cooperation.

We finally would like to thank all current and former employees of centers, where authors of this text work or have worked. Without their continued support, we would not have been able to create such a rich clinical material, which allowed us to write this textbook.

Prague, October 2022
Pavel Douša, Tomáš Pešl, Valér Džupa, Martin Krbec

1. EXAMINATION METHODS IN ORTHOPEDICS AND TRAUMATOLOGY (clinical, laboratory, and imaging)

Filip Svatoš, Jan Ježek

Introduction

Examinations in orthopedics must be complete and thorough, just as in other specialties in medicine. It is important to follow widely accepted algorithms and have enough time for each patient. Empathy is important even for outpatient orthopedists. All findings must be carefully recorded, not only for the purposes of subsequent therapy but also for follow-ups in other disciplines, for research purposes, and also forensic reasons.

History

Family history. We are searching for **developmental abnormalities of the musculoskeletal apparatus**, which may have a genetic basis and thus pose a danger to future generations (e.g. developmental dysplasia of the hip joint). Another group of diseases which may be familial are specific **infections**. We are also keen to ask about family relationships and **living conditions**, in patients undergoing long term treatment.

Personal history. A detailed personal history is taken in patients admitted for hospitalization. We are interested in **past childhood diseases**, including frequent pharyngitis, scarlet fever, or even other serious diseases (e.g. cerebral palsy, meningitis). **Frequently screened diseases** such as thromboembolic disease, diabetes mellitus, cardiovascular disease, infectious hepatitis, tuberculosis, and glaucoma are also inquired about. We try to find about any specific diets, **past surgeries**, whether or not the postoperative period was complicated, which type of anesthetic was utilized, and also where and when it was performed. We are also interested in any past **serious accidents**, when and where they occurred, and whether or not

they left and lasting impact. We try to find out about any general **allergic reactions**, and further inquire about any specific allergies against drugs, contrast material, disinfectants, and metals. We ask about **addictive substances** such as cigarette and alcohol use, or other drugs. Finally, we ask about the patient's **chronic medications**.

Social history. We inquire about the patient's **social conditions**, such as whether or not the patient lives alone or with their family. We ask about current or past **occupation** (in order to see any correlation with the disease). We are interested in the patient's **mobility** before any accident, asking if the patient was moving independently or with the help of crutches or a cane. We try to figure out the patient's **living accommodations**, and its impact on postoperative care and mobility of the patient. Whether the patient lives in a house or apartment building, which floor, and whether or not there is an elevator in the building are asked about. Example: Retired woman, who worked as a seamstress, lives alone on the 2nd floor without an elevator, and before her accident was walking without any support.

Current illness. In patients with chronic disease, we are interested in the beginning of the f**irst symptoms**, their character, progression, reaction to previous conservative therapy, and any previous surgeries related to the diagnosis.

In patients after an accident, we ask about **how the accident occurred**, location, mechanism, and character of post-accident ailments. We try to find out about associated injuries, especially looking out for life threatening injuries.

In both cases we try a chronologic approach, step by step, going through the entire illness. It is important to find out about the exact type of associated **pain**, how it arises, triggering factors, intensity, whether it is continuous or intermittent, any propagation, or any positions which relieve the pain. We ask about **general nonspecific symptoms**, such as fatigue, weakness, or increased body temperature. Here we should also note how the patient came into our care, whether it was via a recommendation from his/her primary care physician, came via the ambulance service, or on his/her own. Example: Female patient fell on her right hip on her way to the toilet around 5am on 25.3.2020, do to pain was not able to ambulate. She did not injure any other part of her body, and was never in a state of unconsciousness. Her son called the Emergency Medical Services, and was transported in a supine position to our clinic.

Clinical examination

During a complete clinical exam of an orthopedic patient, we try to keep all principles associated with examining a patient, as are taught during propeduetics. In subsequent texts we focus on the specifics of an orthopedist's view of a patient.

A basic principle in the examination of the complete musculoskeletal apparatus is that the patient must be undressed (only in underwear), while **standing**, walking or even sometimes in the supine position. Utilizing visual inspection, we can see the symmetry of the patient's figure from four aspects (front, back, and both lateral sides). In the standing position we can appreciate the upright position, while from the back we can assess various bent positions. We try to notice any changes to the figure, deformities, and asymmetries (unequal height of the shoulders, asymmetry of the chest, pectus infundibuliformis, pectus carinatus, cervical lordosis, thoracic hyperkyphosis, straightening or hyperlordosis of lumbar spine, scoliosis of the spine, prominent lower angles of the scapula, asymmetry of space between upper limbs and trunk, pelvic tilt, axis of limbs, weakness of individual muscle groups). We try to assess the stability of the patient during standing on both and individual lower limbs, on both heels and toes, and in the squatting position.

During **walking**, we are interested in any limping. Antalgic gait is frequently related to acute pain and is manifested as a reduction of movement in the affected leg, with a quick response of the healthy leg. We can further classify different types of chronic limping (e.g. Trendelenburg-Duchenne gait which is seen as a tilt of the trunk towards the affected side during standing on the affected leg due to weakened pelvi-femoral muscles, "duck like gait" during bilateral Trendelenburg-Duchenne gait, peroneal gait with raising of the knees due to plantar flexion of the foot). Furthermore, during the gait of the patient we may notice rotational problems during individual phases of the step and flattening of the foot. We palpate to assess any pain and also examine the degree of movement of large joints.

In the **supine** position we often examine the pelvis and lower limbs, and measure their distance (often the DSM – distantio spino-malleolaris – which is the distance between *spina iliaca anterior superior* and the apex of the medial ankle). We must not forget to note the status of the skin overlying any predictive operative site, this is an important info for not only clinical reasons but also forensic ones. Finally, we must include the status of the periphery of the limbs and approximate neurological status.

Laboratory tests

Basic laboratory tests are important for a complete examination of a hospitalized orthopedic patient. In an outpatient setting these types of tests are not conducted often, only in certain circumstances. During the **preoperative** examination of an orthopedic patient, or a patient with an injury to the locomotor system, the following laboratory examinations are often carried out:

1. Blood count.
2. Basic coagulation tests (Quick test often as INR, activated partial thromboplastin time – aPTT), and in patients with a history of hematological disease we include D-dimers, antithrombin III, and fibrinogen levels.
3. Biochemical examination (minerals, urea, creatinine, uric acid, bilirubin, ALT, AST, GMT, ALP, and glucose) and in planned surgeries HBsAg and Wassermann reaction.
4. Chemical examination of the urine, and urinary sediment, cultivation of the urine in patients planned for endoprosthesis implantation.

Other laboratory examinations which supplement a specific orthopedic diagnosis (e.g. inflammation, or tumors), are further discussed in the chapters related to the topic.

Imaging methods

In orthopedics and traumatology of the locomotive apparatus, the main imaging method is X-ray.

Conventional X-ray examination. The principle of conventional X-ray examination is based on the ability of various tissues to absorb X-rays differently. The result is a native summative image, which shows us traumatic changes to the skeleton very well. It imperative to examine the field in **two views**, best if perpendicular planes are used in order to minimize the negatives of summation into one particular field. We examine in standardized views for individual anatomical locations. The positives of this type of examination are its general availability, low radiation dose, and short duration. Negatives are the presence of summative effects. For the diagnosis of injuries in certain localizations (e.g. scaphoid bone, spine, acetabulum, tibial plateau) we utilize special views, which minimize the summative effect in that location.

The utilization of X-ray opaque **contrast material** helps use to examine tissues which would under normal conditions be X-ray translucent, (e.g. arteriography, and fistulography), which further increases the use of X-ray. Currently, we utilize digital technology in the recording of X-rays, allowing us to view quality images in databases and its subsequent archive over various media. This type of recording is much better than previous analogue technology.

Angiography. Application of X-ray contrast material in the vascular system, most often via *a. femoralis* using the Seldinger method with subsequent imaging using Digital Subtraction Angiography (DSA), allows us to view not only the anatomy and pathology of the vascular system, but also even perfusion of interested tissues. The main indication is to understand the vascular supply of a tumor or even in the planning of surgical cases (e.g. osteotomy in the area of the foot and ankle) which have the possibility to disturb distal vascular supply. The advantage is the ability to view anatomical details of the interested vascular supply. The disadvantages on the other hand include invasiveness of the procedure and need for 24-hour bed rest after the procedure. CT angiography has all but replaced conventional angiography.

Fluoroscopy. Modern fluoroscopy allows us to record, thanks to digitalization and quality X-ray amplifiers, to view a dynamic examination used in peri-operative control of bone fragments and osteosynthetic material. The main disadvantage is radiation exposure of the operative team.

Classical tomography. The main principle of this type of examination is the use of a rotative gantry which moves the X-ray generator and detector around a stationary patient. This allows us to view a sharp image, and be able to distinguish various parts within that image. The main indication is localization of bone defects, sequestrations, well-defined bone lesions, and some tumors in some more anatomically complex locations. The advantage, in comparison to computed tomography (CT) is the ability to directly view sagittal and frontal layers, with the disadvantage being a certain fuzziness to the image, today this method has been mostly supplanted by CT imaging using modern CT machine (in the imaging of bones), which allows for 2D post processing and magnetic resonance imaging (MRI), in the imagining of soft tissues.

Computer tomography (CT). The principle of this type of examination is the measurement of differences in intensity of radiation passing through examined layers during a rotational movement of an X-ray source.

A computer then calculates the tissue density and compiles an image of the layer. This method of imaging can be used to advantageously in the examination of the skeleton, imaging of free bodies in joint cavities and in the diagnosis of tumors of the spine and soft tissues. Another advantage is a relatively high tissue resolution without the overlapping of structures, which is important in the examination of the pelvis or the spine. The disadvantage is a higher radiation exposure and the possibility of artifacts arising during the movement of a restless patient or a patient with metal implants. The primary plane used in CT exams is the axial plane (cross sections), other planes can be displayed after computer reconstruction of the digital image (2D reconstruction).

Magnetic resonance imaging (MRI). The principle of this type of examination is the imaging of the de-excitation radio-frequency pulses of hydrogen nuclei in tissues after their excitation utilizing a strong magnetic field. A powerful computer then displays sections of the examined part of the body, in relation to the intensity of the scanned signal, which is proportional to the density of hydrogen nuclei at each location. Soft tissues are imaged especially well. The main indications in orthopedics are injuries, inflammation, ischemia, tumors and degenerative processes of the spine and spinal cord. Advantages include the possibility of imaging in any plane, the possibility of tissue typing and as of now, no known side effects. The main disadvantages are the considerable time and money associated.

Ultrasonography (USG). An ultrasound wave is transmitted into the body by an examination probe, and is subsequently reflected back at the interface of different tissues. This wave then returns back to the detector (which also happens to be the examination probe) at different time intervals, according to the reflection from individual tissue interfaces. A computer then creates an image of a section of tissue whose plane corresponds to the angle of the transmitted ultrasound wave. Indications for this relatively simple examination in orthopedics must take into account that ultrasound does not penetrate into bones, therefore it used in the examination of soft tissue structures (joints, muscles, tendons). Ultrasonography is currently used as a method of choice in the diagnosis of developmental dysplasia of the hip joints in neonatal and infant age, as well as in the detection of increased joint filling in joints covered by excessive soft tissues (e.g. shoulder and hip) and various tendon and muscle diseases (e.g. rupture, hematoma, abscess, and ossifications). The advantage of this type of examination is its non-invasiveness and easy availability.

Scintigraphy. The principle of this type of imaging is the detection of tissue activity utilizing a gamma camera, after giving the patient a radioactive pharmaceutical. Indications in orthopedics include bone tumors, inflammation, and necrosis. Advantages include, the ability to examine the entire skeleton at once and being highly sensitive, which is why it used often in the screening for metastatic disease of the skeleton.

Other imaging methods

Puncture and biopsy. These examinations are relatively undemanding for the patient, and are based on either examining the puncture fluid or small tissue sample, after which it is possible to diagnose a disease which would not be able to be determined by common clinical, laboratory or imaging methods (e.g. inflammation/tumor). Each examination is done in collaboration with either a biochemist, histologist, pathologist, microbiologist, or immunologist.

Examination of punctate. Punctate from a joint cavity or an artificially formed space, in either a muscle or bone, can be examined macroscopically, biochemically, microscopically, cytologically, immunologically, or even cultured. This type of examination helps us in the diagnosis of the primary process, which can either be post-traumatic, sterile inflammation, purulent, or tumorous. We are able further subdivide punctuate into the following groups:

1. **Normal** – transparent, bright light colors, viscosity is slightly higher in comparison to water, glucose value is comparable to serum glycemia, leukocytes values are below 200/mm^3, polymorphonuclear cell values are less than 20%, culture usually yields no results.
2. **Non-inflammatory** – clear, yellow color, viscosity is much higher in comparison to water, glucose value is comparable to glycemia, leukocyte value is in the range of 200–2000/mm^3, cultivation yields a negative result. It usually occurs in post-traumatic conditions, osteoarthritis, osteochondrosis, osteonecrosis, and vilonodular synovialitis.
3. **Inflammatory** – cloudy, yellow to whitish color, viscosity is higher in comparison to water, glucose value is approximately 25% lower than in comparison to serum glycemia, leukocyte value is in the range of 2000–100,000/mm^3, cultivation yields a negative result. It occurs in rheumatoid arthritis, Reiter disease, Bechterew disease, Psoriatic

arthritis, Crohn disease, Rheumatic fever, Systemic lupus erythematosus, Scleroderma, and more.

4. **Septic** – cloudy, yellow to green color, viscosity varies but is usually much higher in comparison to water, glucose value is significantly lower compared to glycemia, leukocyte value is higher than 100,000/mm^3, polymorphonuclear cells are found to be more than 75% of leukocytes, cultivation results are usually positive. It often occurs in bacterial infections
5. **Hemorrhagic** – cloudy, reddish to bloody in color, viscosity is higher in comparison to water, glucose value is comparable to blood glucose, elements of blood cells can be found, the ratio of erythrocytes and leukocytes corresponds to the values found in the blood count, culture is negative. It occurs in fresh traumas, hemorrhagic diatheses, and tumors.

Arthroscopy is not a typical diagnostic method; however, it also allows for a wide range of therapeutic procedures. The main principle is the introduction of an optical part of a device, formed of a bundle of ultra-thin fiberglass fibers, into a joint via a small incision. A second incision is made in order to make it possible to introduce another working tool and treat any affections (e.g. damaged meniscus). We use this examination mainly in the diagnosis and treatment of posttraumatic conditions of the knee and shoulder joint, less often ankle, elbow, and radio-carpal joints. The advantage of this type of examination is the relatively low invasiveness, the possibility of early physiotherapy, short time pf hospitalization and resource sparing.

2. DEVELOPMENTAL DYSPLASIA OF THE HIP

Michal Zídka

Definition

Developmental dysplasia of the hip (DDH), synonymous with the terms congenital hip dysplasia and congenital hip dislocation, is a perinatally occurring condition of the hip joint consisting of a discrepancy in the anatomical relationship between the head of the femur and acetabulum. Changes in the affected hip joint lead to dislocation of the hip, and without proper treatment led to disorders in growth and function of the joint, and even early degenerative changes.

Incidence

The condition has been known about since the time of Hippokrates. Incidence varies significantly among different geographical regions and is also racially dependent. The Czech Republic is in an area of very high incidence – approximately 4% (world average is below 1%). Risk factors include female sex, first-born, post-term birth, children with higher birth weight, breech birth (born pelvis first). The left hip is also more often affected.

Etiology

Affection of the hip joint may be associated with a phylogenetically short period of upright gait, with stress on the lower limbs associated with upright gait being a relatively new trait found in nature. There are various theories regarding the etiology. The only certain factors are hereditary and mechanical, or a combination of both.

Hereditary factors are confirmed by:
– higher incidence in endemic regions with race dependence,
– higher incidence in families with positive health history,
– higher incidence in female sex,
– increased concordance in monozygotic twins.

Mechanical factors are confirmed by:
– higher incidence in babies in breech position,
– higher incidence in first born children, if oligohydramnion is present, in children of higher birth weight,
– higher incidence in tight swaddled children (e.g. Native American, Japanese…),
– higher incidence in children with familiar articular hyper mobility,
– left hip is more often affected (prenatal adduction of the hip is the typical position *in utero*).

Pathogenesis

During ontogenesis, uneven growth of the acetabulum and proximal end of the femur occurs. Prenatally, the femur grows faster than the acetabulum, which significantly accelerates its growth approximately after the 6th postnatal week. Perinatally, this creates a relatively disadvantageous situation where the shallow, cartilaginous acetabulum is not prepared to sufficiently stabilize the large cartilaginous head of the femur. Prenatally, the stability of the joint is not only ensured by the anatomical shape of the acetabulum and the femoral head, but also by a massive cartilaginous labrum surrounding the head itself, nevertheless the hip joint is very sensitive to other possible influences that may disrupt its stability. In the case of any instability and disruption of the acetabular-femoral head proportions, there may be a discrepancy in the ossification and growth of the acetabulum, which further leads to poor bio-mechanical conditions. The proximal femur often increases its degree of valgosity and anteversion, while the femoral head remains smaller. During the start of the child's gait, mechanical forces tend to move the femoral head laterally and proximally, causing the hip to subluxate. Single point force overload of the bone and cartilaginous borders of the acetabulum continue to interfere with its own growth, leading to possible joint dislocation. Pelvic-femoral muscles shorten accordingly,

and the hip may further change position. At the point where the forces are in equilibrium, migration of the joints stops. A new, low-quality, and shallow socket is formed – neoacetabulum. After cessation of growth, the joint undergoes non-physiological loading in the acetabulum (or neoacetabulum) and the head undergoes rapid degeneration (fig. 2.1).

Fig. 2.1 Bilateral high post-dysplastic luxation with osteoarthritic changes

Clinical manifestation

Examination of neonates and infants uncovers asymmetries in skin folds (gluteofemoral, genitofemoral, femoral), symmetrical or asymmetric muscle contractures (especially of the adductors), limitation in movement of the hip joint, unequal length of lower limbs during flexion (Betmen), instability of the joint (Barlow), reposition phenomenon in case of luxation of the joint (Ortolani). In children and adults who are able to walk, we are able to see shortened lower limbs, weakness of the gluteal muscles (Trendelenburg sign), limping (Trendelenburg-Duchenne gait), and decreased range of motion of the joint. Pain of various intensities occurs more often in adolescents.

Diagnostics

Clinical examination. Is a basic orthopedic examination of a newborn. It is performed during the first 3 days after birth at all labor and delivery centers in the Czech Republic. The clinical examination itself (except for the pathognomonic repositioning Ortolani test) only serves to aid in diagnosis, but cannot rule it out (e.g. the possibility of overlooking bilateral non-repositional dislocation in newborns), it does not reveal mild degrees of dysplasia, which may lead to secondary joint dislocation.

X-ray. A native anteroposterior image of the pelvis with both hip joints fully adducted is useful for diagnosing any anomalies from 3 months of age (fig. 2.2).

Fig. 2.2 Marginal luxation of left hip

The use of X-ray as a diagnostic method in a newborn is difficult due to the small degree of skeletal ossification in the area of the hip joint. However, at the age of about three months and later, the pelvis and proximal femur are formed enough to determine the necessary criteria for X-ray evaluation. The shape and angle of the bony roof of the acetabulum, the position of the proximal end of the femur relative to the acetabulum and pelvis, the location of the ossified nucleus of the femoral head and the proximal metaphysis of the

femur relative to the socket and roof are evaluated (e.g. AC angle, CE angle, Shenton line, lateralization of the femur, Sharp angle, parallelogram of Kopitz, Hlavinka line, articulotrochanteric distance, CCD angle, anteversion angle and others). X-ray examination is a static examination, which burdens the patient with radiation. It may fail due to a host of factors such as an uncooperative newborn, and numerous technical errors which may prevent the correct and high-quality evaluation of the image. Currently, it has mostly been replaced by sonography, however we still utilize X-ray, when we monitor the development of the hip into adulthood of only treated patients.

Ultrasonography. Has been used to detect DDH since the 1980s. Ultrasonography is an easy, repeatable examination, which will reveal both static and dynamic pathologies (instability) of the joint. After repeated examinations, we are able to distinguish any changes in the pathology, and hence analyze any response to the treatment. We use Graf examination scheme, which allows us to properly indicate treatment according to the severity of the pathology found. We examine the child ultrasonographically, who is accompanied by a parent, in connection with our clinical examination. In the triple checkup system, the infant is examined ultrasonographically several times. The exam is reproducible from birth to approximately one year of age.

Other methods. In the case that a pathological finding occurs, it is possible to further examine the hip using special X-ray protections and contrast arthrography, which may inform us about the interior state of the hip. Further, it is possible to utilize CT and MRI, however these examinations are difficult to perform on a newborn, and need to be performed in general anesthesia, which is why these are only indicated in severe cases.

Classifications

Clinical classification. We are able to distinguish between hips with a normal finding, hips suspected of pathology, unstable hips, dislocatable hips, dislocated and reponible hips, and dislocated and irreponible hips.

X-ray classification. We are able to distinguish dysplastic, sub-luxated, marginally luxated, and luxated hips. In adults, we are able to evaluate possible degenerative changes such as arthritis (stages I-IV).

Ultrasound classification according to Graf. We are able to distinguish physiologic, physiological immature, critical, unstable, decentred, and dislocated hips.

Therapy

Conservative. Is indicated immediately when the condition is first diagnosed. Prompt treatment is able to completely cure the condition in most instances. Treatment is divided into a few phases: 1. **Reduction phase** centers the femoral head into the acetabular socket, 2. **Retention phase** keeps the femoral head in a stable position within the joint, and allows sufficient growth of the acetabulum. 3. **Removal of medical supports**, when we progressively prepare the joint for physiological workloads. Conservative treatment in mild degrees of dysplasia is treated using medical supports which cause abduction of the joint. **The Frejka pillow**, is a simple abduction brace, is used in the most moderate of cases (fig. 2.3). **Pavlik harness** is currently the method of choice in conservative treatment (fig. 2.4).

It is a system of leather belts, which when properly adjusted, limits extension and complete adduction of the hip joint, while leaving room for rotation and abduction of the hip. Using gravity (weight of the limbs) and application of traction against the muscles of the hip, we are able to free up contractures and properly center the femoral head into the acetabulum. Spontaneous movement of the child, in regulated intervals, also helps in the normalization of the functional state. In some cases, it is even possible to reduce a dislocated femoral head, using this device. Both mentioned treatment devices are well tolerated. The removal of any support is begun when there are signs of normalization of clinical, sonographic, or X-ray findings. If the reduction of the femoral head is unsuccessful, **traction therapy** is indicated. Traction therapy is a system of calculated and regulated pulls of the limb, which is able to directly free any contractures and position the femoral head into the acetabulum (fig. 2.5). The relatively high rate of success is however usually outweighed by the necessity of the long-term hospitalization of both mother and infant, and technical difficulty of treatment. In some countries, other types of abduction treatments are also used, including double hip spica plaster casting (used post operatively).

Surgical treatment. Is indicated when conservative treatment fails to reposition the femoral head. **Open repositioning of the hip joint** is most often performed using anterior access to the joint, and consists of a capsulotomy, freeing repositioning obstacles (most often inversion of the cartilaginous border of the acetabulum — freeing a shortened m. *iliopsoas* or strictures of the capsule, and more), repositioning of the femoral head, and suturing of the capsule in a tight position (technique according Scaglietti

Fig. 2.3 Frejka pillow (published in doi.10.1007/s00402-019-03179-7)

Fig. 2.4 Pavlik harness (published in doi.10.1007/s00402-019-03179-7)

Fig. 2.5 Traction treatment

and Calandriello). In some cases, a severe ante-version of the proximal end of the femur enforces a performance of **subtrochanteric de-rotation osteotomy** and osteosynthesis with plate to correct the pathology. Post operatively, plaster cast fixation is administered for 6 weeks in a repositioned abduction position, after which we use an abduction treatment device. Other operative techniques rely on the reconstruction of the lacking support structure overlying the femoral head in the acetabulum. These types of procedures are indicated as a supplementary procedure to an open reduction, in cases when the lack of femoral head support is so severe, that it does not allow for adequate stability of the joint post-operatively, and also in cases where there is residual dysplasia after conservative or even operative treatment. Other types of procedures used to treat the condition include **pelvic osteotomies**, which reorient the entire acetabulum (e.g. Salter, Steel, Chiari, and Ganz methods), **acetabuloplasties**, which reorient the stress in occurring in the acetabulum (e.g. Pemberton, Dunn methods), and **extraarticular roofing surgery** which uses a bone graft to ameliorate the stability of the femoral head (e.g. Staheli and Bosworth procedures). Each type of operative procedure has exact indication criteria (age, anatomical situation, and previous surgeries).

Complications

Recurrent dislocations (rebellious hip). Severe failure of therapy, usually caused by the following main factors:

– disposition to poor reaction to treatment – the acetabulum does not react to even proper treatment, poor support leads to redislocation of the femoral head (most likely in genetic cases),
– faulty, poor quality or lack of treatment (late or poorly indicated treatment, poorly timed or performed surgeries, uncooperative parents).

In cases where the repositioned hip dislocates, surgical re-repositioning and supplementation with roofing procedures are indicated, which must correct any support deficit. However, further treatment failure may continue to occur.

Ischemic necrosis. Is the most severe iatrogenic complication. Both improper conservative and operative procedures carry a high risk of damaging the growth of the proximal femur (due to the delicate vascular supply of the proximal epiphysis). When the proximal growth physis and the

femoral epiphysis are damaged, necrosis and growth arrest occur, resulting in permanent and sometimes even progressive deformity (flattening of the femoral head and deterioration of acetabular support due to insufficient stimulation of its growth, shortening of the femoral neck with relative overgrowth of the greater trochanter or even valgus growth of the femoral head with secondary sub-luxation). Therefore, patients treated for hip dysplasia should be monitored until adulthood and, if necessary, surgical intervention should be planned in a timely manner in any case of complications. In some indicated cases, the deformity can be cured by the reconstruction of the proximal femur using various types of osteotomies in the area of the trochanters.

Residual acetabular dysplasia is a prearthritis condition. In the case that the acetabulum fails to develop, the hip joint is threatened by degenerative processes. The goal of the acetabular roof reconstruction is to fix the pathological state before any arthritis develops. In any case of irreversible changes to the hip joint, a total hip replacement is indicated. Due to the anatomical changes in hips affected by DDH, this procedure is difficult to perform, and is burdened by difficulty in choosing the type of prosthesis, and high rate of complication or even failure of the procedure.

Prognosis

DDH is the most common cause of hip osteoarthritis in young people. The development of X-ray diagnostics at the end of the 19th century uncovered the essence of the condition, and also aided in the development of conservative and operative treatment methods. Sonography also allowed for early detection and treatment of the condition. The Czech Republic was and still is the leader of modern treatment of DDH. The names of Czech orthopedists are still cited in literature worldwide, whether it is **Professor Pavlik** or **Professor Frejka**, their medical devices are still being used worldwide. Even **Professor Zahradníček**, was one of the protagonists in developing the original operative techniques in the treatment of DDH. The "**system of triple orthopedic check-ups**" regarding preventative checkups of the population, was begun in the post war period in Czechoslovakia, and is still unique worldwide. Thanks to our long history and tradition, the care for DDH in the Czech Republic is world class. The use of sonography in screening dramatically improved results of treatment and reduced the

amounts of surgerys used in the treatment of these patients. Due to the various risk factors related to this condition, eradication is currently not feasible. With proper treatment, long term outlook is very positive, and most patients meet excellent results in hip function. Otherwise, people with DDH continue to be a large group which will continue to be candidates of total hip replacement in middle age.

3. CHILDHOOD DISORDERS OF THE HIP EXCLUDING DDH (transient synovialitis, Legg-Calvé-Perthes disease, coxa vara adolescentium)

Jiří Záhorka

Transient synovialitis of the hip

Definition

Aseptic inflammation of the hip joint accompanied by increased production of synovial fluid.

Incidence

Transient synovialitis occurs equally in both sexes throughout childhood, however it occurs predominantly in preschool age children. It usually affects single joints (monoarticular), very often affecting the hip, but other locations may also be affected (e.g. knee, ankle, elbow, wrist).

Etiology

It typically occurs as a para-infectious process, however it may also occur post-traumatically. Synovitis of various joints, including the hip joint, fall under rheumatic diseases. When the hip joint is affected, synovialitis may cause necrosis of the femoral head.

Pathogenesis

Transient synovialitis is a reactive inflammatory process with an increased production of synovial fluid. The increased volume of synovial

fluid may lead to the compression of femoral neck vessels and thus, worsening the perfusion of the femoral head, and according to some authors, may even lead to the development of necrosis in the femoral head. Therefore, a follow-up examination is recommended 2 to 3 months after transient synovialitis of the hip joint is diagnosed. The patient is cleared if clinical complications resolve, and the X-ray findings show no evidence of proximal femoral epiphyseal necrosis.

Clinical manifestation

Subjective complaints. The child usually complains of pain in the groin area or pain on the inside of the thigh, even reaching down to the knee. Less often, pain is felt in the gluteal region. Symptoms usually begin from complete health ("he was still running on the playground with the other children yesterday"), after which the child refuses to stand on the affected limb. When taking the full health history of the patient there is usually a note of an upper respiratory tract infection which has occurred in the last 7 to 10 days, or less often, a history of unusual loading on the joint a few days before the onset of symptoms.

Objective findings. In the beginning, the child avoids putting weight on the affected limb, and guards against any type of examination of movement in the hip. The joint is often in the antalgic position (flexion with abduction). If the child allows for any clinical examination, it shows a decreased range of motion in each direction, with pain. If the condition is long standing, the child will walk, however with an antalgic gait.

Diagnostics

Laboratory tests. May yield a mild increase in nonspecific laboratory markers (leukocytes, CRP), but these are most likely due to the upper respiratory tract infection finishing its course.

Imagining methods. A native **X-ray** image shows no findings. **Ultrasonography** shows increased synovial fluid in the joint. If the findings are still unclear, an examination of aspirate from an arthrocentesis may be performed.

Differential diagnosis

We must always confirm that there is no necrosis of the proximal femoral epiphysis (Legg-Calvé-Perthes disease – more below). In any cases of repeated synovialitis of a single or multiple joint, and in any case of positive family history, we must take into account a possible rheumatic etiology of synovialitis.

Therapy

Treatment is always **conservative**, often consisting of a few days of rest or easy going – we try to ensure that the child does not run, walked minimally or even not at all. NSAIDs are recommended and ameliorate the state within a few days. Antibiotics are considered only in cases of prolonged upper respiratory tract infections, and in making this decision, it is usually best to consult with a pediatrician. In the case that a large effusion is detected in the joint, an arthrocentesis and drainage may be performed to decrease pain.

Complications

As mentioned before, the most severe complication that may arise is aseptic necrosis of the proximal epiphysis of the femur. Another severe complication is the progression of "aseptic" synovialitis into "purulent" coxitis, which may occur due to hematogenous spread of an infectious focus from a distant site.

Prognosis

The prognosis of transient synovialitis of the Hip is very good. Usually, all difficulties cease after 10 to 14 days. The importance of a follow-up checkup was already mentioned earlier.

Legg-Calvé-Perthes disease

Definition

Aseptic necrosis of the proximal femoral epiphysis – the disease was described in 1910 by three independent authors (American Arthur T. Legg, Frenchman Jacques Calvé and German Georg C. Perthes).

Incidence

The disease may occur in children ages 3 to 14, however it most often occurs in children aged 5 to 7. It occurs four times as often in boys and may be bilateral in some cases. As was previously mentioned, it may occur as a result of transient synovitis of the hip. There is also increased incidence in children of older parents. Incidence is 1:9000 children.

Etiology

Two theories exist:

1. The disease occurs after a transient obstruction of extraosseous (femoral neck) circulation which perfuse the proximal femoral epiphysis due to various etiologies (e.g. increased joint filling during synovitis, or changes in blood viscosity in some diseases).
2. It occurs due to a systemic disorder of growth cartilage.

Pathogenesis

The disease occurs over several stages. Primarily, a worsening of proximal femoral epiphysis perfusion leads to necrosis, this stage does not have any clinical or imaging findings – it is regarded as a **potential disease state**. Re-perfusion of the proximal femoral epiphysis leads to new bone formation and restoration of quality and weight bearing capability of the proximal femur. If, however, remodeling of the bone is overloaded by outside forces, a subchondral fracture may occur, this regarded as a second ischemic attack. This physical change leads to the development of symptoms and even has a correlated X-ray image – known as **true Legg-Calvé-Perthes disease**. In the following months, reperfusion occurs again, leading to further remodeling of the proximal femoral epiphysis. The definite

shape of the femoral head in adulthood is determined by whether or not proper treatment was achieved.

Clinical manifestation

Subjective complaints. Pain is located in the groin area, sometimes even in the gluteal region, but even often occurring on the medial side of the thigh and knee. Knee pain in preschool aged boys should lead us to a possible diagnosis of Legg-Calvé-Perthes disease.

Objective findings. As the patient enters the examination room, we can notice an antalgic gait, which is characteristic for the beginning stages of the disease. During examination of the hip movement, we can find restriction in its rotation and duction, and pain in the maximum locations. In long standing disease antalgic gait is adapted to Trendelenburg-Duchenne gait (see chapter 1).

Diagnostics

Laboratory test. Often does not bring any new information, in some children we can find mildly increased non-specific inflammatory markers (leukocytes, CRP), which most likely do not correlate with Legg-Calvé-Perthes disease at all.

Imaging methods. Native summative **X-ray** imaging, taken in anterior-posterior view in the Lauenstein view, may show a reduction in the proximal femoral epiphysis and changes in its structure, meaning condensation

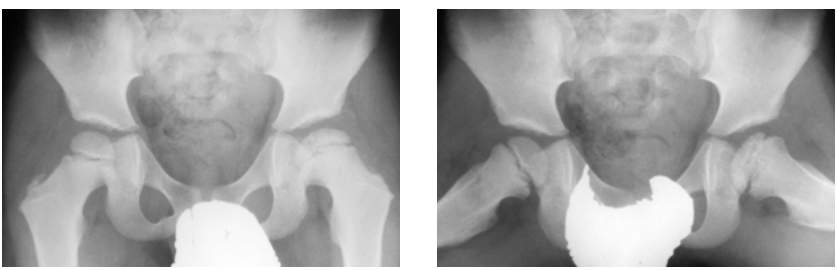

Fig. 3.1 Anterior-posterior and Lauenstein X-ray views with reduction in size of the proximal femoral epiphysis, its condensation, and a discrete subchondral fracture line on the left

of the entire epiphysis and even subchondral fractures (brighter subchondral stripe – fig. 3.1). **Ultrasonography** may show accumulation of liquid in the joint space. **Arthrography** shows the state of the outer joint cartilage and is indicated in deciding the type of operative treatment. **MRI** and skeletal **scintigraphy** are able to detect early stages of disease, usually in the primary phase of hypo-perfusion, even when X-ray imaging are unremarkable.

Classifications

When deciding treatment and following up status of a patient, a classification system based on X-ray findings is used. It is divided up into three groups:

- classification based on the phase of the disease,
- classification describing degree of affection of proximal femoral epiphysis,
- classification describing the definitive state of the acetabulum, femoral head, and congruency of the hip joint after remodeling.

Differential diagnosis

Findings associated with changes in the structure and shape of the proximal femoral epiphysis, which are similar to changes seen in Legg-Calvé-Perthes disease, may be due to treatment of developmental hip dysplasia (known as post-dysplastic necrosis), further known as Mayer dysplasia, which almost always has a good prognosis. Finally, some complex epiphyseal dysplasias with necrosis of articular ends of various bones must also be taken into account.

Therapy

Therapy is based on the so-called "containment" principle. The goal is to "embed" the necrotic portion of the proximal femoral epiphysis into the acetabulum so that it is not in direct contact with the supporting portion of the acetabulum. The way to achieve "containment" is either conservative or operative. The choice of treatment for a particular patient is determined by the extent of involvement of the proximal epiphyseal head (when the epiphysis is reduced by more than half, we prefer surgical treatment)

and the patient's age at the onset of the disease (if the child is younger than 6 years of age, operative treatment is less likely, however when the child older than 9, the surgical treatment is preferred).

Conservative. Conservative "containment" may be achieved using abduction aids, which hold both lower limbs in abduction, and if possible, in internal rotation of the hip. The aid is needed for the entire time of bone remodeling, approx. 6 months. One of the preferred aids is called the Atlanta brace (fig. 3.2).

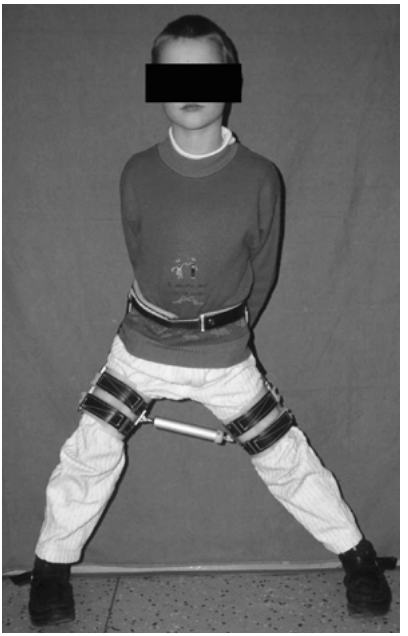

Fig. 3.2 Atlanta brace

Surgical treatment. Currently is the preferred method of treatment, because when "containment" is reached operatively it is permanent, and independent of proper usage of abduction aids. "Containment" may be achieved either using a supraacetabular osteotomy of the pelvis and changing the shape or orientation of the acetabulum, or using an inter-trochanteric variable osteotomy of the proximal femur (reducing the diaphysial angle), or a combination of these methods.

Complications

Changes of femoral head shape may lead to early onset arthritis in adulthood, meaning that Legg-Calvé-Perthes disease is considered a pre-arthritis state. Definitive treatment of coxarthrosis is a total hip replacement, which can be delayed by performing an intertrochanteric valgus osteotomy of the proximal femur (fig. 3.3), which improves both morphologic and bio-mechanic properties of the hip and may even improve congruency of the articular surfaces.

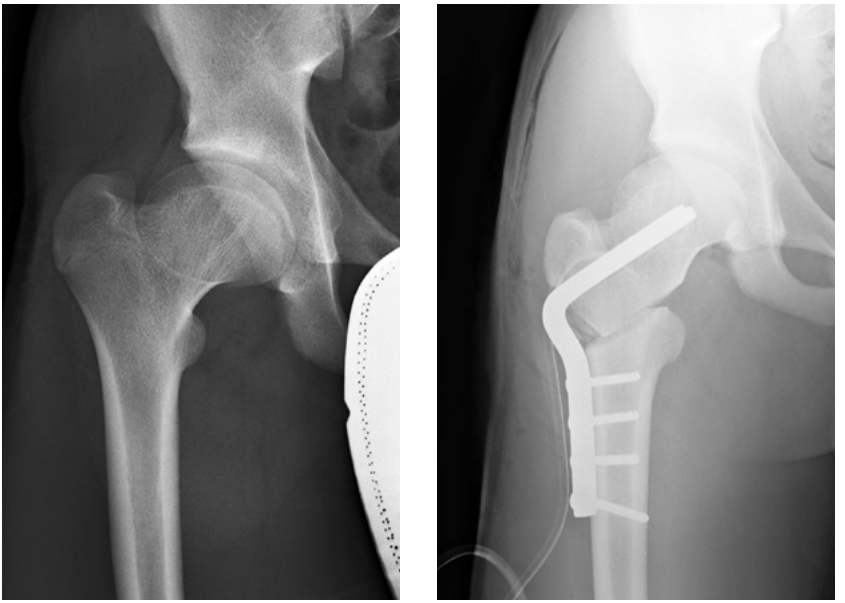

Fig. 3.3 Changed shape of the proximal femur after treatment with an intertrochanteric valgus osteotomy for Legg-Calvé-Perthes disease

Prognosis

During treatment, a number of activities must be limited, including sports. However, proper treatment often leads to complete recovery of hip joint function and delays the development of coxarthrosis to the end of the patient's active career.

Coxa vara adolescentium

Definition

Slippage of the proximal femoral epiphysis in adolescent age.

Incidence

The disorder occurs in pre-puberty and puberty (in girls aged 10–12, in boys aged 12–16). Boys are affected two-time as much as girls. Some authors have speculated that 80% of patients are affected bilaterally.

Etiology

The etiology of adolescent coxa vara is usually described by two theories:

1. **Hormonal** – which believes that growth plate cartilage at the end of the growth period is vulnerable, meaning that it is not as elastic as it was in the beginning of childhood, and on the other hand is still not tough and remodeled as bone in adulthood. Reduced elasticity and rigidity at the cartilage-bone border is related to increased amounts of sex hormones.
2. **Mechanical** – which believes the disorder is due to some sort of trauma.

Pathogenesis

Slippage in most patients is progressive in the area of the physis, after overloading, where the growth plate is changed by the hormonal mechanism mentioned above. It is important to note that is still possible that a rapid slippage of a large part of the proximal femoral epiphysis may occur between the metaphysis due to a traumatic mechanism, even though even in this instance, poor mechanical properties of the growth plate in adolescents plays a possible instigating role.

Clinical manifestation

Subjective complaints. Parents often try to assign a specific injury to when the disorder began, however it is usually possible to detect a gradual increase in the patient's difficulties through history alone. The pain is usually deep within the groin with possible propagation to the thigh or gluteal region.

Objective findings. The patient walks using an antalgic gait into the clinic. Examination of the hip joint shows reduced movement in all directions. **Drehmann sign** is pathognomic for this disorder, which is when the examiner moves the hip joint from extension to flexion, the hip lightly externally rotates – we say, "the knee points towards the axilla".