

UČEBNÍ TEXTY
UNIVERZITY KARLOVY

SELECTED CHAPTERS IN ORTHOPEDICS AND TRAUMATOLOGY FOR MEDICAL STUDENTS

Pavel Douša
Tomáš Pešl
Valér Džupa
Martin Krbec
editors

KAROLINUM

Selected chapters in orthopedics and traumatology for medical students

Pavel Douša, Tomáš Pešl, Valér Džupa, Martin Krbec (eds.)

Reviewers:

Jana Chmelová, MD, PhD, Assoc Prof
Tomáš Pavelka, MD, PhD, Assoc Prof
Pavel Šponer, MD, PhD, Prof

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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 post-operative 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 **first 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 propedeutics. 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 is 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 $200/\text{mm}^3$, 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 $200\text{--}2000/\text{mm}^3$, 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 $2000\text{--}100,000/\text{mm}^3$, 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/mm³, 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 of hospitalization and resource sparing.

2. DEVELOPMENTAL DYSPLASIA OF THE HIP

Michal Zidka

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 Hippocrates. 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