Solutions

Mirja Wenker, Martina Kahl-Scholz, and Christel Vockelmann

M. Kahl-Scholz, C. Vockelmann (eds.), *Basic Knowledge Radiology*,
https://doi.org/10.1007/978-3-662-66351-6_27

In this chapter you will find the solutions to the practice questions asked in each chapter.

Chapter 1

1. **Photoelectric effect**: If photon radiation hits matter, the entire energy can be transferred to an electron of the atomic shell (photoabsorption). The shell electron is either raised to a shell of higher energy (excitation) or knocked out of the atomic shell (ionization). The latter occurs when the energy of the photon exceeds the binding energy of the electron to the nucleus. The remaining energy is transferred to the electron (photoelectron) as kinetic energy. The photoelectric effect is the basis of imaging in diagnostic radiology, which works mainly in the energy range up to 100 keV. The radiation emitted by the X-ray tube is attenuated differently by tissues of different density, such as bone, soft tissue, fat or connective tissue, so that the resulting radiation image has different gray scales depending on the attenuation. **Compton scattering:** In the so-called Compton effect, the photon emits only part of its energy to the shell electron of an outer shell and is scattered with its residual energy in a different direction. Secondary electrons of lower energy are emitted in lateral direction, those of higher energy in forward direction. Scattered photons lead to image degradation in radiological, diagnostic and nuclear medical imaging techniques. Technical aids, such as a scattering grid consisting of lead lamellae in radiological diagnostics or the exclusion of low-energy scattered photons by placing an appropriate energy window in nuclear medicine, can minimize the impact of scattering effects. **Pair formation**: At high photon energies above 1022 keV, the so-called pair formation effect occurs. Here the interaction does not take place in the shell but in the strong electric field of the atomic nucleus. Near the nucleus, the photon can form an electron-positron pair, consisting of a negatively charged electron and a positively charged positron. The atomic nucleus remains unchanged. Here, in contrast to the pair annihilation, a pair is formed which, however, emits two annihilation quanta of 511 keV each with one electron of the absorber. The energy release via the pair formation effect plays an essential role in radiation therapy when ultra-hard photons are used.
2. **Incident dose:** This describes the dose in Gy that is measured "free air" without stray bodies. By scattering bodies are meant phantoms or also patients, which would lead to a scattering of the radiation. The incident dose depends on the focal distance, energy (in X-rays kV and filter) and the dose rate. The field size has only little influence. **Surface dose: In** addition to the incident dose, the backscatter from the irradiated object, e.g. the patient, is added to the surface dose. On the entrance side, the backscatter can be up to 50%. The backscattering is strongly dependent on the field size. In radiotherapy, the surface dose on the exit side is also important, since this must be taken into account in the case of opposing fields. More about this later. **Depth dose**: The depth dose describes the dose at a certain body depth, measured from the irradiation surface. The relative depth dose indicates the ratio of a depth dose to the dose maximum in percent. The depth dose is particularly important in radiation therapy, since here a specific dose at a specific location in the body, e.g. a lung tumor, is targeted for therapeutic success. At the same time, surrounding healthy tissue should of course not be damaged.
3. **X-ray deceleration radiation is** produced by the deceleration of electrons at the nucleus into which they cannot penetrate. Some electrons release radiation as soon as they hit the anode. Others penetrate deeper into the electron material,

give off part of their energy and produce X-rays only afterwards. As a result, the electrons produce X-rays with different wavelengths. How much X-ray radiation is released depends on how strongly the electron is decelerated. The immediately produced X-ray deceleration radiation has a smaller wavelength than the radiation produced by the initially decelerated electrons. **Characteristic X-ray radiation is** produced in addition to the X-ray deceleration radiation and is a so-called line spectrum, which depends exclusively on the anode material. It is therefore characteristic for this material.

4. Since the **Linear Energy Transfer** (LE) serves rather the physical consideration of the radiation effect, there is also the term **Relative Biological Effectiveness (RBE)**. It is used, among other things, to subdivide the health hazard posed by the various types of radiation. In this context, the effects that can be observed with different types of radiation when the same dose is administered in grays are put in relation to each other.
5. **Stochastic radiation effect**: With regard to the effect of ionizing radiation, each individual X-ray quantum can cause an undesirable, damaging event in the organism. The probability of this event depends on how many radiation quanta strike the organism. Thus, the highest commandment of radiation protection is derived from the stochastic radiation effect: "As Low As Reasonably Achievable" (ALARA principle)—one may only administer as little radiation as absolutely necessary, since there is no threshold dose for a certain radiation damage. **Deterministic Radiation Effect:** This term means something like "delineation" or "determination". In the context of radiation exposure, it is therefore possible to determine the resulting damage to a tissue. It is known, for example, after how much radiation the healthy skin reacts with a skin reaction (burn). Accordingly, there is a threshold dose. This is defined for each tissue. From the point of view of radiation protection, deterministic damage must not occur. From the point of view of therapy, however, it is precisely this damage that is "desired", since research results can prove when the threshold dose of a tumor is also reached. In radiation therapy, deterministic damage to malignant tumors is specifically set.

Chapter 2

1. An X-ray **system** always consists of the following components: an X-ray source that generates the radiation, an X-ray generator that supplies the X-ray source with high voltage, an X-ray application device that is used to position the patient, and an X-ray image converter (X-ray film, detector, …).
2. While overexposure, i.e. too much radiation, does not harm the quality of the image, an **underexposed shot** results in an image that shows much less detail. This phenomenon is also called image noise.
3. $V = B/G = b/g$. In X-ray imaging, the distance g is called the **focus-object distance** and the distance b is called the focus-film distance (FFA). The distance $B–G$ is called **object-film distance** (OFA). The variable V indicates the magnification of the image.
4. **Shielding:** When an X-ray is taken, the patient must of course be exposed to the X-rays. However, if possible, all parts of the body that are not being examined should be shielded from the radiation. Most aids for this purpose are made of lead or lead compounds ("lead rubber"). Depending on the organ being examined, the patient can be protected in various ways. In particular, the organs that are sensitive to radiation should be protected. First of all, these are the gonads, i.e. the ovaries in women and the testes in men. However, the small intestine and the hematopoietic tissue are also particularly

sensitive to radiation. Ideally, the patient should always wear a lead apron or a lead coat when the extremities are imaged. Infants can also be completely wrapped in so-called radiation protection wraps. For images of the chest area, a half apron (gonadal protection apron) or a radiation protection skirt must always be worn to protect the lower half of the body from radiation. When taking images of the pelvis or hip, it is not possible to put on a half apron, as this would cover the bone. There are special lead covers for these shots, depending on gender. **Blending in**: One of the most effective methods of minimizing X-ray radiation is to blend in the radiation field. Thus, by blending in, you not only protect the patient, but you also get a better quality x-ray. **Additional filters/compensating filters**: Filters were mentioned at the beginning of this chapter. These also contribute to the radiation protection of the patient. The filters in the depth diaphragm harden the rays so that the radiation that does not contribute to the image formation does not reach the patient in the first place. **Radiation quality**: The dose to the patient can also be minimized by changing the radiation quality. Whereas a few years ago, for example, the fingers were x-rayed with a voltage of 44 kV, the Medical Association now prescribes a voltage of at least 50 kV. This makes it easier for the rays to pass through the bones and the current intensity can be reduced. With the introduction of digital imaging techniques, the lower contrast that results from the higher voltage can be increased again by suitable image processing.

5. A digital image consists of many individual pixels. These are arranged in rows and columns, this arrangement is then called a **pixel matrix** or **matrix** for short. Depending on the system, an X-ray image consists of between 1024 × 1024 and 4096 × 4096 pixels. One speaks of a 1024 matrix or a 4096 matrix.

27

Chapter 3

1. The **Heel effect** refers to the anode-side dose drop.
2. Due to the **compression of the breast,** the tissue is distributed homogeneously both thoracic and mammillary and can thus be assessed more precisely.
3. In **magnification mammography**, the distance between the breast and the image receiver is increased. Due to the imaging laws, this achieves an enlargement of the structures, e.g. in order to better recognize the shape of microcalcifications, even if the geometric blurring becomes somewhat greater. In addition, the grid can be dispensed with for the magnification image, since the scattered radiation is already too far attenuated and no longer reaches the image receiver.

Chapter 5

1. Answers:
   (a) Setting fractures,
   (b) Examinations of the gastrointestinal tract and other body cavities (e.g. the gall bladder) using contrast media,
   (c) Examinations of vessels also with contrast media,
   (d) Placement of probes or drains in the body,
   (e) Consideration of real-time processes in the study of the swallowing act and valvular activity.
2. By the function "**Last-Image-Hold (LIH)**" the last image remains on the monitor, can be stored digitally and thus replace an additional X-ray.
3. The **image receiver** and the **X-ray tube** are connected by a **semicircular rail,** which is anchored to the rest of the system by means of a holding module. This holding module can rotate and can also be moved so that the tube can move sideways along the patient (= images in all spatial directions are possible).
4. Digital subtraction angiography **(DSA)** is an application used primarily for the visualisation of vessels using contrast media.

5. These are used in the **seldinger technique.** With them (especially balloons and stents), the wire is only guided through a second lumen of the catheter for the first 20–30 cm, after which it runs freely parallel to the catheter. In addition to the shorter wires, this also allows a faster catheter change, but the guidance of the catheter is somewhat worse, since the wire reinforcement is only given at the catheter tip.

Chapter 6

1. Motion artifact, pulsation artifact, metal artifact, partial volume effect, hardening artifact, measurement field overrun, photon starvation artifact, ring artifact, line artifact.
2. In sequential CT examinations, one slice is acquired per rotation, after which the table is advanced before the next examination section is acquired. In **spiral CT,** the table is moved continuously, the raw data is acquired as a helix and an axial image is calculated from this.
3. **Adaptive Array Detector** and **Fixed Array Detector**. In the "Adaptive Array Detector" the detector chambers become wider and wider towards the periphery. This leads to the possibility of interconnecting individual elements and rows with the option of different layer thicknesses. With the "Fixed Array Detector" there are fixed sizes of detector elements per detector row. By selecting certain detector rows, the layer thickness can be determined.

Chapter 7

1. With a targeted look at a sure aqueous-filled structure in the image (e.g., CSF or bladder). If the fluid is brightly imaged, the image is **T2-weighted**. If the fluid is dark, the image is **T1-weighted**.
2. A T2 weighting with fat saturation—here fluid—i.e. also an oedema is mapped hyperintensely. The fat saturation helps to distinguish the edema from the fat, which is also hyperintense in T2 weighting.
3. E.g. **intracranial aneurysm clips**, **pacemakers/ICDs, neurostimulators, insulin pumps, bladder catheters with temperature probes** (there are also MR-compatible materials among the implants mentioned—their suitability must be checked in advance). But also shrapnel or claustrophobia (if there is no alternative examination possibility, sedation of the patient may be necessary).
4. It depends on the region of examination. Smaller arterial vessels (e.g. intracranial) can be imaged with **TOF angiography**. Slow-flow vessels (e.g. sinus veins) can be imaged with **phase-contrast angiography.**
5. In addition to the immediate life-saving measures such as emergency call and CPR, you must now also pay attention to the safety of patients and staff: The patient must be out of the exam room as soon as possible, and if possible, a person should stand guard outside the door for as long as possible. The resuscitation team or paramedics may not appreciate the dangers of the device. If they instinctively run to the patient immediately, emergency cases and oxygen cylinders brought into the examination room become life-threatening projectiles.

Chapter 8

1. The **piezo effect** is caused by the contraction and elongation—i.e. compression and expansion—of the crystal during ultrasound. An applied external electrical voltage causes the emission of vibrations, i.e. sound waves (=sound wave emission). If the sound waves encounter an impedance jump (wave resistance) on their way, e.g. at the border between fatty tissue and water, they are reflected and received as an echo or resonance on the quartz crystal. The resulting sound pressure deforms the crystal and the electrical charge is shifted. This piezo effect creates a measurable electrical voltage, which is recorded by the connected electronics and displayed as an image.

2. **A-mode**: The A-mode is the oldest method. "A" stands for amplitude modulation. Today, the method is still used for distance determination in ENT, ophthalmology and neurology. In the early days, before the development of computer tomography, this method was used, for example, to detect a midline shift in a brain tumor. **M-mode**: With the M-mode (from English "motion") the temporal behavior of a tissue can be imaged. It is used in particular in cardiology. A typical example is the imaging of the movement of a heart valve or the myocardium. **B-mode**: The B-mode (English "brightness") is the most frequently used procedure. In the 2D image, the various image points are recorded with different brightness grey dots, depending on the strength of the reflected signal.
3. Blood flow toward the transducer is coded red; blood flowing away from the transducer is coded blue. Faster blood flow is shown lighter than slower flow. In the image on the right, a corresponding coding is shown with an indication of the measured flow velocity.
4. A special form is the so-called **pocket Doppler**, in which the ultrasound probe looks like a thick pen. It is mainly used in vascular diagnostics to measure occlusion pressure.
5. Ultrasound diagnostics is the **primary diagnostic** imaging for abdominal complaints, vascular diseases and for the diagnosis of cardiac function.

Chapter 9

1. **X-ray contrast agents** are divided into two major groups:
   (a) Substances with lower density than the environment to be imaged = negative contrast media (gases, water, methyl cellulose, sorbitol)
   (b) Substances with a higher density than the environment to be depicted = positive contrast media (differentiation into water-soluble, water-insoluble and oil-containing)
   (c) The accumulation of gadolinium in a tissue depends on the general condition of the patient (fever), the waiting time after the injection and the dose ("much helps much"). The contrast medium may "behave differently" in a patient with fever than in patients without fever. This can play a role in the findings.
2. **Double contrast** is the performance of fluoroscopy with a positive CM (usually barium) and a negative CM (e.g. cellulose, water, CO_2).
3. Response:
   (a) Absolute contraindications
      - Severe kidney dysfunction not previously requiring dialysis
      - Manifest hyperthyroidism
      - Sensitivity to iodine-containing KM
      - Certain thyroid carcinomas
   (b) Relative contraindications
      - Heart failure
      - Severe hepatic dysfunction
      - Hematological diseases (Waldenström's disease)
4. 1% CM is found in the **mother's milk**. That this amount has a harmful effect on the infant has not yet been proven. The current recommendation does not call for any special measures. Nevertheless, a 24-hour breastfeeding break can be considered.

Chapter 10

1. **IMRT:** IMRT (Intensity Modulated Radiotherapy) is a further developed method of conformal irradiation. During irradiation, the multileaf lamellae move across the irradiation field. This is done either in sliding-window technique, the irradiation runs while the MLC move, or in step-and-shoot technique, the irradiation is interrupted during the movement of the MLC. This allows the dose to be varied from point to point. In this way, tumors can be irradiated with a high dose and sensitive

organs that are in close proximity can be spared more effectively because the reduced dose can be shaped more precisely to the organ contour. The disadvantage of this method is the dose load for healthy tissue. **VMAT**: Volumetric Modulated Arc Therapy (VMAT) is a further development of the IMRT technique: The number of small dose-modulated fields increases, which are irradiated in many different gantry positions. For this purpose, the gantry no longer remains stationary at the individual positions, but moves in a circle or semicircle. This significantly shortens the irradiation time.

2. This refers to **radiotherapy** that is **applied in** a **spatially targeted and highly precise manner.** The method was developed for brain tumors, but is now also used in the rest of the body as body stereotaxy, e.g. for primary tumors and metastases in the lungs and liver, as long as the tumor diameter is not larger than 3 cm.
3. **Intracavitary:** The classic indication for intracavitary brachytherapy is vaginal application for irradiation of the vaginal stump in corpus carcinoma. However, it is also possible for small superficial carcinomas in the esophagus or other cavities. **Interstitial**: The radionuclide is introduced into the tissue either temporarily or permanently. The procedure always involves surgery and anesthesia. Under ultrasound control, the radiation sources made of ^{125}iodine (= seeds) are introduced via a hollow needle and remain in the tissue, e.g. in the prostate in the case of carcinoma detection. Depending on the size of the prostate, their number is between 80 and >100, their dose rate is low (Low Dose Rate, LDR, <1 Gy/h), the half-life is 60 days. **Contact therapy:** Contact therapy is rarely performed because the area to be irradiated must be small and superficial. In addition, this very special method is only used to treat tumors that cannot be irradiated in any other way, e.g. with electrons or conventional X-ray therapy, and for which surgery is not an option because the risk of anesthesia is too high or functional impairment, e.g. blindness, is to be expected.
4. The **boost** is applied to a macroscopic tumor or to an area where there is an increased risk of recurrence, e.g. at the site where surgery could only just be resected or not in healthy tissue. Percutaneously, it is applied in several sessions; with interstitial or intracavitary brachytherapy, it is occasionally applied as a single application. It is possible to perform the boost sequentially, i.e. following the radiation series, or during the radiation series either concomitantly or as a simultaneously integrated boost (SIB).
5. **Tumor volume** (GTV = Gross Tumor Volume): GTV includes the macroscopic tumor, be it the primary tumor, be it lymph node metastases or distant metastases. Clinical Tumor **Volume** (CTV): The CTV encompasses the area of macroscopic tumor (GTV) and the region where tumor cells may still be scattered. Planning Target **Volume** (PTV): The planning target volume (PTV) includes the CTV and is expanded with respect to changes that may occur during radiation. These include: Positioning inaccuracies by the MTRA, patient restlessness, organ movements due to breathing, peristalsis (wave movement of the intestine), different filling states of the bladder and rectum, but also weight gain or loss.

Chapter 11

1. Distance, stay, activity, shielding, avoid recording.
2. Keep **radiation effect** on persons as low as possible by decontamination, avoid further spreading.
3. Collimator, NaJ crystal, photomultiplier, electronic data processing.
4. Radioiodine therapy with ^{131}NaI. Benign diseases: Thyroid enlargement, autonomy, Graves' disease. Malignant disease: papillary and follicular thyroid carcinoma.

5. Radiology uses **transmission radiation**, nuclear medicine **emission radiation.**
6. Alpha radiation therapy (e.g. bone metastases), beta-minus radiation therapy, beta-plus radiation diagnostics (PET), gamma radiation diagnostics.
7. **Coincidence** refers to the nearly simultaneous impingement of annihilation beams in the PET ring system.
8. **Single photon emission computed tomography (SPECT):** Creation of a three-dimensional image based on images taken at different angles and suitable back projection.

27

Chapter 12

1. Intolerance reaction to the KM.
2. To a thyrotoxic crisis.
3. In patients at risk, perchlorate (irenate) is used prophylactically before and 1–2 weeks after the examination with a thyrostatic. Perchlorate decreases iodine uptake into the thyroid gland.
4. Cardiac massage: find a hard surface if not already available → pressure point in the middle of the chest (lower half of the sternum) → compression depth approx. 4–5 cm → 100 compressions; ventilation: after the first 30 compressions (frequency 100–120/min) → first ventilation cycle of approx. 1 s with ventilation twice; continue as above in the ratio 30 (cardiac compressions):2 (ventilations).
5. If a tonic-clonic seizure lasts longer than 5 min or if an entire series of seizures occurs without the patient regaining consciousness in the meantime, this is referred to as status epilepticus. The danger here is an undersupply of oxygen (hypoxia) and dangerous cardiovascular stress.

Chapter 13

1. **The** patient should be **informed** about the planned measures in such a way that he/she can decide for him/herself whether the planned procedure makes sense for him/her (**self-determination information**). To this end, the patient must be informed about the risks of the planned treatment, but also about the risks that may arise if the measure is not carried out. The actual treatment information includes the concrete treatment (e.g. computer tomography) with possible risks (e.g. contrast medium incident with anaphylactic shock). In the end, it is not the frequency of risks that is important, but the consequences. For example, possible lethal complications must be mentioned, even if their probability of occurrence is very rare but possible. Information must also be provided on possible alternatives to the proposed procedure, especially if there are in fact two approximately equivalent procedures.
2. The **X-ray Ordinance** regulates areas with X-ray radiation with a limit energy of more than 5 keV and less than 1 MeV. The handling of radioactive substances and ionizing radiation not covered by the X-ray Ordinance is regulated by the Radiation Protection Ordinance.
3. Examinations may only be performed if a competent physician has provided the **"justifying indication"** according to § 23 RöV or § 80 StrlSchV. It must be assessed whether the benefit of the planned examination outweighs the risk of radiation exposure and whether the question cannot be answered by another examination with lower radiation exposure.
4. No, working in the controlled area is possible under certain conditions.

Chapter 14

1. An **epidural hemorrhage is** located under the dura and is limited biconvex. In addition, the cranial sutures are respected. A **subdural hemorrhage** spreads along the dura, which includes the falx cerebri, and can be delineated concavely. Subdural hemorrhages may cross the cranial sutures.
2. Bleeding in the **basal ganglia** and in the **pons** is considered typical and is usually due to hypertension. In other hemorrhage localizations, one must search for a cause for the hemorrhage.

3. **Tumor edema** spreads finger-like into the gyri, the cortex is usually preserved, whereas ischemic edema involves the cortex in most cases.
4. In the case of a **space-occupying lesion** in the **cerebellopontine angle**, one has to think of a **meningioma,** an acoustic neuroma (=wannoma) and/or an epidermoid tumor.

Chapter 15

1. DD **mucocele shadowing vs tumor shadowing of** the NNH: thinning of the wall without destruction in mucocele.
2. An **anechoic lumen, a smooth wall structure** and a distal **sound amplification** are shown.
3. Midface fractures are classified according to **LeFort** into:
   (a) LeFort I = basal detachment of the maxilla
   (b) LeFort II = pyramidal detachment of the maxilla including the bony nose
   (c) LeFort III = high avulsion of the entire midfacial skeleton including the bony nose
4. In the case of an **orbital fracture,** if the force is exerted directly on the eye, a so-called blow-out fracture can occur, in which the orbital floor fractures and orbital content can enter the maxillary sinus, which then becomes visible as a so-called "hanging drop".

   In **sialography**, which can also be used to visualize salivary stones, the orifice of the salivary glands is probed with a fine cannula and filled with CM to enable better visualization in conventional X-rays, CT or MRI. This also allows tumors to be visualized.

Chapter 16

1. A **breast carcinoma** can be delineated on sonography as an echo-poor, blurred round focus, possibly with dorsal sound extinction and above all with interruption of the longitudinal connective tissue structures (Cooper's ligaments).
2. To an **inflammatory breast carcinoma**. Clinically and mammographically, mastitis and inflammatory breast carcinoma look very similar: in addition to a thickened cutis, a diffusely condensed breast parenchyma can be seen.
3. One possible form of therapy **is** the **embolisation of fibroids**. This involves probing the feeding artery with a catheter and then closing it off with the help of small particles. The fibroid dies from the lack of oxygen and hopefully no longer stands in the way of the patient.
4. You think of an **inflammatory process with accompanying** edema. Your suspicion is adnexitis.
5. The **indications** are: positive lymph node involvement, tumor size: over 4 cm, from FIGO III primary radiochemotherapy is usually performed as combined tele- and brachytherapy, adenocarcinoma, R1/2 or narrow tumor-free resection margin.

Chapter 17

1. <10 U = transudate, >10 U = exudate.
2. The X-ray shows the following characteristics:
   (a) Kerley B/C line = interstitial edema in the interlobular septa in the form of a reticular pattern.
   (b) "Frosted glass phenomenon" due to intralobular edema.
   (c) Peribronchial cuffing = oedema formation in the peribronchial interstitium.
   (d) "Washed out" Hilus.
   (e) Subpleural edema.
3. p = pinhead, q = micronodular, r = nodular.
4. **Initial phase = Up to** 1 h; interstitial pulmonary edema with patchy indistinct condensations develops; **early phase = 1–24** h; alveolar pulmonary edema with microthrombi and rapid fusion to homogeneous condensations; **intermediate phase = 1–7** days; microatelectasis, fibroblast proliferation and regression to patchy shadows; **late**

phase => 7 days; pulmonary fibrosis with regression of patchy shadows, reticular pattern (= irreversible fibrosis).
5. In pulmonary embolism. Conventional X-rays show a regional reduction in blood flow, which reduces the diameter of the vessel and results in a secondary increase in transparency (so-called **Westermark sign**). Furthermore, there is a so-called **knuckle sign**, an enlargement with a jump in calibre, which results from the ballooning of the central artery and a resulting clear difference in size to the continuing vessels.

Chapter 18

1. **Primary sclerosing cholangitis** is a sclerosing chronic inflammation and destruction of the intra- and extrahepatic bile ducts and is manifested on ERCP (gold standard) or MRCP by a pearl cord-like duct irregularity.
2. Response:
   (a) **Zenker diverticulum**: 70% of all diverticula, cervical pulsatile diverticulum. Preferred in men of older age. Large pseudodiverticulum localized dorsally at the upper esophageal jugular predominantly on the left side.
   (b) **Bifurcation diverticulum**: True diverticulum due to scarring, e.g. after TBC.
   (c) **Epiphrenic pulsatile diverticulum**: Pseudodiverticulum above the hiatus, often combined with hiatal hernia or achalasia.
3. **Krukenberg tumor** is a drip metastasis of gastric carcinoma in the ovaries or in the Douglas space.
4. A**ppendicitis** presents as a cocard >7 mm. The wall is thickened to >3 mm. Often an appendicolith is detectable.
5. During the **sigmavolvulus**, i.e. the rotation of the sigmoid colon around its mesenteric axis, the coffee bean sign appears.

Chapter 19

1. First, order a urinalysis, especially with the question of hematuria, and a sonography of the abdomen. If the diagnosis of **urolithiasis** remains suspected, perform a low-dose CT of the urinary tract.
2. **Bland renal cysts** are hydrous in all imaging techniques, i.e. anechoic with dorsal acoustic enhancement, in CT with density values around 0 HU and in MRI fluid isointense in all sequences. Complicated renal cysts may be hemorrhaged or septated with corresponding changes such as anechoic contents of the cyst or hyperdense appearance on CT. Contrast enhancement cannot be detected in cysts; should you detect this, it can no longer be assumed to be a cyst.
3. The **benign prostatic hypertrophy** affects the central zone around the urethra and has an inhomogeneous structure, the prostatic carcinoma is located in the peripheral zone and there mainly dorsal. In MRI the carcinoma is T2w hypointense with signal enhancement in diffusion due to cytotoxic edema.
4. Depending on the tumor stage, primary surgery, radiotherapy alone or hormone ablative therapy or a combination of hormone ablative therapy and radiotherapy.
5. Calcifications of the vasa deferens of the seminal vesicles or the interdigital arteries are almost pathognomonic for the presence of **diabetes mellitus**.

Chapter 20

1. **Definite fracture signs**: Axial malalignment, open fractures with bone fragments protruding from the wound, steps or gaps in the course of the bone, crepitation. Uncertain fracture signs: pain, swelling, redness, hyperthermia, restricted mobility (functio lesa). X-rays should always be taken in two planes.

2. Type of lesion, bordering of the lesion, cortical changes, periosteal reaction, assessment of the matrix, growth rate as an expression of aggressiveness, localization.
3. **Protrusion**: Bulging disc in which the diameter of the protrusion is greatest at the base. Extrusion: Bulging disc in which the diameter of the protrusion is greater peripherally than at the base (hourglass shape). **Bulging**: broad-based disc protrusion beyond the vertebral body, where the protrusion occupies more than 180 ° of the disc circumference. **Sequester**: extrusion in which at least part of the herniated disc tissue no longer has a connection to the residual disc).
4. **Tumor embolisation**: angiographic embolisation of osseous metastases, e.g. renal cell carcinoma. Pain therapy: PRT for the treatment of herniated discs. CT-guided treatment of bone tumors: thermoablation for osteoid osteoma.

Chapter 21

1. **DeBakey**: Type I (ascending aorta affected downstream of the supraaortic vessels), Type II (ascending aorta affected upstream of the supraaortic vessels), Type III (aorta affected distal to the supraaortic vessels). **Stanford**: Type A: Ascending aorta is involved. Type B: Aorta distal to the supra-aortic vascular branches is affected).
2. First determine pretest probability (according to Wells), not high: D-dimer determination, if negative no treatment, high probability: direct compression ultrasound, if negative no treatment, if positive treatment, in case of inconclusive findings supplementary phlebography or control ultrasound in four to seven days.
3. CT and MRI are equivalent in principle, but since there is often an emergency situation, CT is given priority for rapid clarification.
4. **Acute occlusion**: lysis, thrombectomy. **Chronic occlusion**: PTA, stent implantation.

Chapter 22

1. Autonomous adenomas.
2. On CT, **adenomas** show hypodense and take up contrast.
3. The **MRI**.
4. An examination with **iodine-containing contrast media** (6–8 weeks before diagnostics) as well as contamination with **iodine-containing food** represent a contraindication of thyroid scintigraphy, because otherwise the applied ^{99m}Tc cannot be transported into the thyroid tissue due to saturation. An undesired medicinal TSH suppression of the patient should be avoided.
5. To detect catecholamine-producing pheochromocytomas, **^{123}J- or ^{131}J-labeled MIBG** is administered.
6. The most important benign indications for radioiodine therapy are **functional autonomies, Graves' disease and euthyroid strumen**. A corresponding indication for the therapy of malignant tumors is the still existing functional similarity to the thyroid tissue. This is the case with papillary (approx. 70% of malignant thyroid tumors) as well as follicular (approx. 20% of malignant thyroid tumors), the so-called differentiated thyroid carcinomas.

Chapter 23

1. As with sonography, computed tomography can detect the fatty hilus as a fatty isodense central zone in the lymph node even in relatively large lymph **nodes** in the groin. This is indicative of benignity of the lymph node. An absent fatty hilus is a sign of pathologic change, such as malignancy or inflammation. The shape also plays an important role in the evaluation of the lymph node as in sonography. A further indication of malignancy or benignity results from the localization of the lymph node.

2. For an **echinococcus cyst**.
3. **Thymomas** and **thymic carcinomas** usually present as a well circumscribed soft tissue mass in the upper anterior mediastinum. Vascular infiltration or sheathing as well as pleural metastases are indicative of malignancy. Magnetic resonance imaging (MRI) of the thorax may be helpful in rare cases to assess vascular infiltration.

Chapter 24

1. The **single-flush catheter** is placed over a suitable vein under sterile conditions and should be positioned in front of the right atrium. The beginning of the catheter should always be imaged as well, since the catheter may have already coiled up at the beginning. The **umbilical vein catheter** is placed via the umbilical vein through the ductus venosus Arantii into the inferior vena cava and is used, among other things, for the possibility of an exchange transfusion or for measuring the central venous pressure. The catheter should end 1 cm above the diaphragm. The **umbilical artery catheter** is used to measure pO_2 in ventilated premature infants. The appropriate position should be above the diaphragm, at a safe distance from the outlet of the renal arteries.
2. **Respiratory distress syndrome (ANS)** can occur in premature infants <28th week of gestation due to lung immaturity, in shock situations and, for example, in infants of diabetic mothers. Stage IV corresponds to white lung on X-ray.
3. Your tentative diagnosis is **intussusception**. This is an invagination of a part of the intestine into the following caudal part of the intestine. This leads to strangulation of the mesenteric vessels with edema, stasis hemorrhage, intestinal necrosis due to ischemia.
4. For imaging, an **MRI of the entire craniospinal axis** must be performed. In the T2 image, the solid part of the tumor is predominantly hyper- to isointense to the cerebellar cortex and shows a heterogeneous appearance. The T1-weighted image shows a predominantly hypo- to isointense, heterogeneous tumor.