Incidental Findings on Abdominal CT

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Contents

The original version of this chapter was revised. Water marks and line numbers have been removed.

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Abdominal CT examinations usually cover the entire abdomen and pelvis, including all organs and tissues in the intraperitoneal, retroperitoneal, extraperitoneal/pelvic spaces, as well as the extra-abdominal soft tissues, bony structures of the spine, sacrum, pelvis, and hips, and lower part of the chest including parts of the lungs and pleural spaces. The multitude of organs and tissues involved makes abdominal CT reading complex and allows for a multitude of incidental findings that may be of degenerative, neoplastic, or other etiologies. Although scanning is sometimes limited to only the "abdomen" or only the "pelvis," "abdominal CT" in this chapter refers to abdominal-pelvic CT, i.e. both compartments.

The following chapter does not intend to cover every aspect of incidental abdominal CT findings or systematically cover all abdominal organs but concentrates on some general aspects and highlights some relevant organ-specific incidental findings in adults. Incidental findings in the chest are discussed in another chapter.

1 Misunderstandings About Incidental Findings/ Incidentalomas

An incidental finding, sometimes called incidentaloma, can be described as a radiological finding not intentionally searched for or an incidentally discovered mass or lesion, detected by CT or other imaging modalities, performed for an unrelated reason. The terms incidental finding and incidentaloma are therefore inappropriate when the radiological finding is related to the clinical question or to the clinical symptoms or signs that motivated the CT examination. Thus, incidentaloma and incidental finding are inappropriate terms when, for example, a tumorous lesion is identified in a patient with a history of cancer, as the lesion may represent a metastasis related to the known malignancy. The same logic applies when there is high clinical suspicion of a malignant process in a patient without known malignancy. In such a case, the organs and tissues are intentionally scrutinized for masses at any location, and therefore the finding of a lesion in, e.g., the adrenal, may not be entirely incidental. Nevertheless, such a finding may still be benign and thereby "incidental" in relation to what was expected or searched for (i.e. metastases or malignant disease). In rare circumstances, the examination may reveal an unsuspected "second" malignancy, which then, by definition, is incidental in relation to the already known "first" malignancy.

The term incidental finding can also be discussed from other aspects. The meaning and use of the term incidental finding or incidentaloma depend on how much, and how specific, clinical information is given on the request form. This in turn may depend on the clinical situation and on the individual referring doctor formulating the request form. With a very specific clinical question, the likelihood of classifying other "nontargeted" radiological findings as incidental may be high, while the same radiological findings may be covered by a broader, more unspecific clinical question and thereby less likely to be called incidental. Incidental radiological findings also need to be related to previous radiological and other information. A finding that appears incidental in relation to the clinical question may already be known from previous studies and thereby not truly incidental, although it may be incidental to the reporting radiologist, if he or she does not have access to previous examinations. The term incidental finding or incidentaloma is therefore best applied to findings that are not previously shown on radiological examinations. The usually non-standardized text summarizing the patient history and clinical questions on radiological request forms and variations in interpretation by the radiologist of the clinical question, in addition to variations in diagnostic interpretation of the actual radiological images, means that comparisons of frequencies of incidental findings in different studies are, to be modest, uncertain.

One may also argue that if the frequency of a certain diagnosis in a defined population is known from previous studies, such as the frequency of abdominal aortic aneurysm (AAA) in 65-year-old men, the identification of such an aneurysm in a 65-year-old male patient is not entirely unexpected, even if not asked for by the referring doctor. On a population basis, such a finding is thereby not entirely incidental. However, the finding in the individual patient may still be incidental if not covered by the clinical question. The term incidental finding is therefore best applied on an individual patient basis.

Incidental findings that are masses or tumor-like are often called incidentalomas, for example if affecting the adrenal (adrenal incidentaloma). It is important to understand that the term incidentaloma is not a diagnosis but only a description of *how* a lesion was identified, i.e. incidentally. Not uncommonly, the term is incorrectly used by radiologists and clinicians to denote a benign finding. In fact, the term incidentaloma says nothing about the character or etiology of the lesion found. Thus, an incidentaloma may be benign or malignant – and it may be clinically unimportant or important.

2 How Common Are Incidental Findings on CT of the Abdomen?

2.1 Abdominal CT

The frequency of incidental findings in abdominal CT is strongly related to the age, sex, and clinical background of the studied population, and it also depends on the criteria used for definition of incidental findings.

In a recent retrospective study of 1,040 consecutive abdominal contrast-enhanced CT examinations, performed for a variety of reasons (mean age 66 years), "relevant incidental findings," i.e. findings leading to further imaging, clinical evaluation, or follow-up, were found in 19% of the examinations (Sconfienza et al. 2015). Such incidental findings were slightly more common in inpatients (23%) than in outpatients (15%), and there was an increase with patient age. The distribution among the involved organs was the kidneys (14%), gallbladder (14%), lung (12%), uterus (10%), adrenal (10%), and vessels (10%). The most common findings were gallstones (in 3% of the examinations), uterine lesions (2%), adrenal masses (2%), non-simple renal cysts (1%), lung nodules (1%), adnexal masses (1%), and kidney stones (1%). In total, 39 different types of relevant incidental findings were made on the 1040 contrast-enhanced abdominal CT examinations. It is notable that the frequency figures were based on a review of the radiology reports and not on a review of the CT images. Therefore, these figures should be considered minimum figures.

2.2 CT Colonography

In CT colonography, the clinical question is focused on the rectum and colon itself. However, a CT colonography examination covers the entire abdomen and pelvis, from the diaphragm to the symphysis pubis, and thereby allows full assessment of colonic as well as extracolonic organs and tissues. It may be argued that by using 3D virtual colonoscopy image reconstructions and 2D images zoomed-in at the colon with wide window-settings, it is theoretically possible to fully assess the colon and rectum without proper visualization of, and attention to, the extracolonic tissues. There is, however, a general agreement that evaluation of extracolonic organs and tissues should be an integral part of CT colonography. Thus, the ESGAR CT colonography Working Group states that "the extracolonic organs should be interrogated and abnormalities reported, noting the limitations if an unenhanced and/or low-dose technique was used" (Neri et al. 2013).

Extracolonic findings are very common on CT colonography, and the majority of these can be considered as incidental findings, although the terms are not entirely interchangeable. Extracolonic findings are commonly categorized as being of minor, moderate, or major importance. Findings of major importance are usually defined as those that potentially lead to further imaging, surgical procedures, or clinical follow-up. In a CT colonography study, mainly including screening subjects, at least one extracolonic finding was made in 55% of those aged 41–64 years and in 74% of those aged 65–92 years (Macari et al. 2011). More importantly, clinically significant findings leading to a recommendation for further radiological imaging were made in 4–6% of the same population. This suggests that the vast majority of incidental findings are of minor clinical importance but also that relevant findings are made in a smaller proportion of those screened. In two large CT colonography screening studies in asymptomatic individuals (over 10,000 and 2,000 participants, respectively), unsuspected extracolonic cancers were identified with similar frequency as (Veerappan et al. 2010), or even higher frequency than, in the colon itself (Pickhardt et al. 2010). In a more recent publication, 2.5% of an asymptomatic screening population had extracolonic findings of potentially major clinical importance, and in nearly 70% of these, significant pathology was proven at follow-up (Pooler et al. 2016a, b).The findings primarily involved the vascular system (26% of the cases, including aortic and other aneurysms), the urogenital system (18%), the liver (15%), the gastrointestinal system (10%), the lungs (9%), and the gynecological system (7%). Considering that screening for abdominal aortic aneurysms can be performed simultaneously, it has been suggested that CT colonography is a highly cost-effective screening method (Pickhardt et al. 2009). Nevertheless, the question about the potential and real impact of extracolonic findings on long-term morbidity and mortality, cost-effectiveness, and acceptance of CT colonography for screening remains a major issue, not least for decision-makers regarding general societal imbursement.

In symptomatic patients investigated with CT colonography, previously unknown extracolonic findings of major importance have been found in 7–13% of the cases (Hellstrom et al. 2004; Badiani et al. 2013) and in the symptomatic elderly in up to 24% (Tolan et al. 2007). In the large SIGGAR study on CT colonography in symptomatic patients, extracolonic findings were made in 59% and further investigated in 8.3% of the population (Halligan et al. 2015). Extracolonic findings are more common in older, as compared to younger, patients (Khan et al. 2007; Macari et al. 2011) and in females, due mainly to findings in the female reproductive organs (Khan et al. 2007).

It is obvious that extracolonic findings may constitute important medical information in both asymptomatic and symptomatic patients. Despite this, it has sometimes been suggested that extracolonic findings on CT colonography should be reported by the radiologist only if specifically asked for. However, the high frequency of significant extracolonic (incidental) findings implies that extracolonic findings should always be looked for and reported when of clinical significance.

Most studies on incidental findings classify the importance of the extracolonic findings as minor, moderate, or major, exemplified in a recent systematic review (Lumbreras et al. 2010). In order to standardize and facilitate reporting of extracolonic findings on CT colonography, classification within the CRAD CT colonography categorization system has been proposed (Zalis et al. 2005). Extracolonic findings are categorized as E0–E4:

- *E0*: “Limited examination. Compromised by artifact; evaluation of extra-colonic soft tissues is severely limited.”
- *E1*: “Normal examination or anatomic variant. No extra-colonic abnormalities visible.” Example: retroaortic left renal vein.
- *E2*: “Clinically unimportant finding. No work-up indicated.” Examples: renal or hepatic cysts, gall stone without cholecystitis, or vertebral hemangioma.
- *E3*: “Likely unimportant finding, incompletely characterized. Subject to local practice and patient preference, work-up may be indicated.” Example: minimally complex or homogeneously hyperattenuating kidney cyst.

- *E4*: "Potentially important finding. Communicate to referring physician as per accepted practice guidelines." Examples: solid renal mass, lymphadenopathy, aortic aneurysm, and nonuniformly calcified parenchymal lung nodule ≥1 cm.

3 How Extensively Should We Look for Incidental Findings on Abdominal CT?

The primary focus of abdominal CT is usually to reveal or exclude abnormal findings in the abdominal, retroperitoneal or pelvic organs, or soft tissues. This is normally done with soft tissue CT window settings, optimized for the liver, kidneys, and other soft tissues. However, organs and tissues outside the field of interest are also automatically included during scanning, e.g. the lung bases, the spine, the pelvic bones, and proximal parts of the femurs. Detection of abnormal findings in these locations requires that different CT window settings (window width, window level), optimized for the soft tissues, lung, and bone, respectively, are actively chosen. Also, full evaluation of the included parts of the lungs and bones may require evaluation in more than one image plane, such as axial and sagittal and/or coronal planes. In theory, full evaluation of an abdominal CT should thus include the abdomen in three planes with soft tissue and lung windows (for distribution of intra- and extraintestinal gas and abnormal gas collections), visible parts of the chest in three planes with CT windows for the lung and mediastinum, and visible parts of the spine and pelvic bones in three planes with bone window. Such a comprehensive analysis is rarely needed to answer the clinical question and is probably not routinely performed by most radiologists. In a busy clinical setting, the focus in abdominal CT is rather on the main clinical question, i.e. the intra-abdominal structures, using axial and coronal image planes with soft tissue windows, with image reconstructions in the sagittal plane used for problem-solving. Most radiologists probably also make an overview of the spine with bone window in the sagittal plane and of the pelvic bones in the axial or coronal plane to look for any unexpected clinically significant findings. The extent to which appropriate window settings are used in daily radiology practice is, however, largely unknown and probably depends on individual preferences, personal experience, and routines, as well as on the clinical situation, including patient age, comorbidity, clinical indication, and the radiologist's work situation (restrictions depending on emergency situations, workload, available reading time). On the other hand, ethical and medicolegal considerations and fear of malpractice, which have an impact on the radiologist's decision-making, may promote overly meticulous assessment routines that may become inefficient and expensive. Thus, it is uncertain to what extent radiologists in different clinical situations make full use of available image information in CT of the abdomen. This, of course, has an impact on the detection and reporting of incidental findings on abdominal CT.

4 Technical Factors Affecting the Detection and Characterization of Incidental Findings on Abdominal CT

One factor of importance for incidental findings is the image quality. In abdominal CT, it is today common to use low-radiation dose techniques, especially in younger patients. Using low x-ray tube current with fewer photons emitted creates more image noise, although this may to a large extent be compensated for by iterative reconstruction techniques that are used increasingly. Increased image noise may potentially make incidental findings less conspicuous and thereby less common but may also create artifacts that may be interpreted as potential pathology, findings that perhaps would have been dismissed as normal, if standard radiation dose had been used. In a study on CT pulmonary angiography (Kumamaru et al. 2014), a low kVp did not affect the detection of incidental lung findings, as compared to standard kVp. Other studies have reported the frequency of incidental findings using low mAs (Surov et al. 2014; Priola et al. 2013; Pickhardt and Hanson 2010) but without comparing incidental findings with standard radiation dose. Comparative studies on image quality of specific anatomical targets using low- and standard radiation doses have also been published (Bodelle et al. 2016). However, there is little information in the literature from comparative studies, using low- and standard radiation dose in the same patient.

Another technical factor of importance for abdominal incidental findings is the use of intravascular contrast media. Intravenous contrast media facilitates not only detection but also characterization of lesions on abdominal CT. Low-radiation dose and non-enhanced abdominal CT is typically used in patients with, e.g. flank pain in search for urinary stones and in acute abdomen when bowel obstruction or gastrointestinal perforation is searched for but also, e.g. in screening CT colonography. In CT colonography, it has been shown that extracolonic findings are more common in patients given intravenous contrast media than in those without (Yau et al. 2014). In symptomatic patients, CT colonography with routine use of both non-enhanced and contrast-enhanced image acquisition is recommended, thereby reducing the frequency of ambiguous interpretation of extracolonic organs and tissues, especially regarding cystic and solid lesions (Neri et al. 2013).

5 Kidneys

5.1 Solid Renal Tumors

Incidental findings in the kidneys are common and thus of special interest. An increasing proportion of renal cancers are detected incidentally on imaging examinations performed for unrelated reasons (The Swedish National Quality Registry for Kidney Cancer 2015). In 2015, 63% of newly diagnosed renal cancers in Sweden were detected incidentally, an increase from 43% in 2005. Most of these cancers are detected on CT examinations of the abdomen and sometimes on CT of the chest, while MRI of the abdomen and spine and abdominal ultrasonography contribute to a lesser extent. Data from The Swedish National Quality Registry for Kidney Cancer shows that incidentally detected renal cancers are smaller (mean 54 mm) than those presenting with symptoms (77 mm) and thereby of lower stage with potentially better prognosis. This is reflected in statistics on the mean size of all newly detected renal cancers over time, decreasing from mean 60 mm in 2005 to 50 mm in 2013 (The Swedish National Quality Registry for Kidney Cancer). The proportion of newly diagnosed renal cancers of stage 1a (<4 cm) increased from 22% in 2005 to 35% in 2014, most likely representing an effect of earlier diagnosis by incidental detection on radiological examinations.

Incidental detection of small renal cancers before they show local spread or metastasize may undoubtedly be lifesaving in some patients. Although not presently proven, the lower overall tumor stage at diagnosis should reasonably, in a longer perspective, be accompanied by improved survival for renal cancer patients as a group. Therefore, there seems to be good reasons for the radiologist to take the time and effort to thoroughly assess the kidneys in abdominal CT and other imaging examinations that may include the kidneys, irrespective of the clinical question.

On the other hand, many renal tumors detected incidentally are small or slow growing, being indolent in nature and perhaps of little clinical significance, especially in patients with significant comorbidity or a limited life expectancy. Such patients may die with, rather than from, renal cancer. Identification of an increasing number of small early cancers, together with the increased availability and use of relatively noninvasive interventions such as percutaneous tumor ablation techniques (radiofrequency, microwave, or cryoablation), increases the number of candidates for potential curative treatment. Incidental detection of renal tumors thereby creates a growing reservoir of potentially treatable patients (Welch and Black 2010). Not knowing which individual patients run a real risk of significant morbidity or mortality from their renal tumor may lead to overdiagnosis and overtreatment.

The term overdiagnosis is used when an increase in detection of a specific cancer is not accompanied by a corresponding decrease in clinical morbidity or mortality. A largely unchanged mortality rate, despite an increase in detection of renal cancers, may also be due to a parallel improvement in surgical and medical treatment and care, but overdiagnosis is probably a strong contributing factor, as suggested by Bae (2015). For clarity, "overdiagnosis" as a term is different from "false-positive" test results. Overdiagnosis means that the diagnosis of, e.g., cancer is correct, but the cancer is of no harm, while false-positive test result means diagnosis of cancer when there is no cancer.

Another complicating factor is that 10–15% of solid renal tumors are benign (Al Harbi et al. 2016) but difficult to differentiate from malignant tumor by imaging, even when using multiphase contrast-enhanced CT. Also when using biopsy, differentiation may sometimes be difficult. A remaining challenge for the future is therefore to find ways to better differentiate benign solid renal tumors from renal cancers and to differentiate those renal cancers that grow, metastasize, and thereby cause harm, from those that do not (Karlo et al. 2016). At present, incidentally detected renal masses of suspected solid nature on CT should be reported by the radiologist and further characterized by non-enhanced and contrast-enhanced CT in the corticomedullary and/or nephrographic phase as minimal requirements. Ideally, four-phase CT including also imaging in the excretory phase for visualization of the collecting system should be used, unless patient radiation is an issue, taking age and comorbidity into consideration. As tumor size and imaging characteristics have limited predictive capacity, percutaneous tumor biopsy has gained increased interest as a basis for decision-making, since it offers histologic parameters and molecular markers which may aid the individual therapeutic planning and prognostication (Bagrodia et al. 2012). In particular, image-guided biopsy should be performed when imaging findings are suggestive of lymphoma or metastasis (Campbell et al. 2009).

The increasing proportion of incidentally detected renal cancers may evoke thoughts on general population screening for renal cancer. Using ultrasonography, large-scale screening studies have been employed in Japan. Tsuboi et al. (2000) screened over 60,000 persons in 1993–1997 with a wide age span (15–95 years). They found tumor-suspected renal lesions in 0.16% and confirmed cancers in 0.02% of the population. Mihara et al. (1999) examined nearly 200,000 persons with abdominal ultrasonography over a period of 13 years (1983–1996) with the majority in the age span of 30–60 years. Renal cell carcinoma was identified in 0.08%, and 38% of the tumors were 25 mm or smaller. Ninety-eight percent were operated, and the 5-year survival rate was 97.4%, much higher than for other abdominal cancers identified in the same screening population. They suggested a very good outcome for renal cancers detected at screening. However, a number of criteria need to be fulfilled to motivate general screening, and so far, screening for renal cancer has not been generally accepted as cost effective and medically relevant and is therefore not generally employed. As mentioned above, the risk of overdiagnosis (Bae 2015) is also an important factor when discussing general population screening for renal cancer. On the other hand, scrutinizing diagnostic information already available on clinical radiological examinations, such as abdominal CT, provides a form of opportunistic or collateral screening on behalf of the radiologist, with no extra radiation or cost. This is a different situation from general screening, and seems highly relevant, but the diagnostic information gained must be handled sensibly by the responsible clinicians, in symphony with the needs and preferences of the patient. Radiologists should also contribute to the better understanding of the biology of renal cancers by performing careful follow-up studies and developing methods for improved characterization of small, incidentally detected renal tumors.

Finally, radiologists need to care about incidental renal (and other) findings from ethical and medicolegal aspects. Neglected or missed "incidental" renal cancers may grow and metastasize over time. If the patient comes back a few years later with symptomatic metastatic renal cancer, it

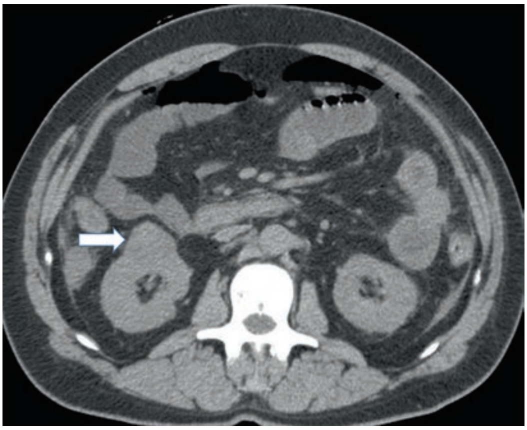

Fig. 1 A 46-year-old male with acute abdominal symptoms, unenhanced abdominal CT shows perforated diverticulitis with free abdominal gas (not shown). Incidentally, a right renal mass, isodense with renal parenchyma, was noted (*arrow*). Follow-up with contrast-enhanced CT showed clear cell renal carcinoma, histologically confirmed at surgery

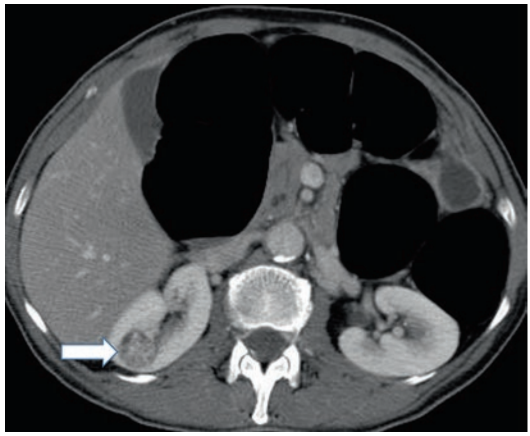

Fig. 2 A 61-year-old woman with bowel symptoms examined with CT colonography. On the supine, contrast-enhanced series (above), a 2 cm solid, diffusely contrast-enhancing tumor is noted in the right kidney (*arrow*). This lesion was not detectable on the prone, non-enhanced series, as it was isodense with normal parenchyma and not exophytic. Surgical removal showed clear cell renal carcinoma

is difficult for the radiologist to explain, and difficult for the patient to understand, that the kidneys were not the focus on the previous examination, when the potentially curable, small renal tumor was already apparent but not looked at or not reported. Clearly, such a scenario also evokes medicolegal issues.

On non-enhanced abdominal CT, solid renal tumors are easy to identify when large and exophytic, i.e. causing a bulge of the renal contour (Fig. 1). If endophytic, i.e. not reaching the normal renal outline, the tumor may be difficult to detect, unless contrast enhancement is used (Fig. 2). However, even a bulging tumor located in the upper or lower pole may be difficult to detect on axial images, as it may mimic a normal or somewhat prominent normal upper or lower renal pole, while it may be obvious on coronal or sagittal views. Similarly, tumors may be difficult to see on coronal views if located anteriorly or posteriorly. This emphasizes the importance of scrutinizing the kidneys in multiple views. If the tumor is large enough, density measurements (Hounsfield numbers) are reliable and may show values over 30–40 HU on native image series, indicating the solid, and not cystic, nature of the lesion, even without the proof of a contrast-enhanced image series. In any case, renal lesions suspected of being solid should be further characterized with CT without and with intravenous contrast medium, in order to determine the degree of contrast enhancement, tumor tissue heterogeneity, and tumor delineation and to rule out local overgrowth beyond Gerota's fascia or into adjacent organs, to rule out tumor thrombus into the renal vein and vena cava, and to assess lymph node involvement. An important aspect is also to assess the function and morphology of the contralateral kidney. Most renal tumors are well depicted in the nephrographic phase (Al Harbi et al. 2016). For preoperative assessment, especially when resection is planned, the arterial anatomy visualized at CT angiography in the corticomedullary phase is of interest. Ideally, a four-phase CT should therefore be performed: non-contrast phase, corticomedullary phase, nephrographic phase, and excretory phase. If radiation dose is a concern in younger patients, three-phase CT should be performed, including non-contrast phase, nephrographic phase, and excretory phase, i.e. CT urography as defined by ESUR (Van Der Molen et al. 2008). Additional radiation dose reduction may be obtained by split-bolus injection techniques, which limit the CT scanning to one pre-contrast scan and one

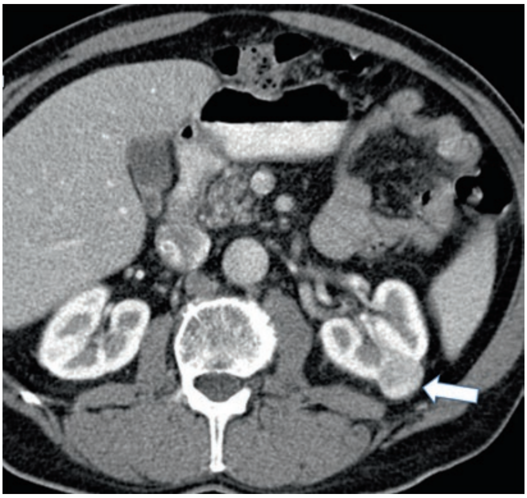

Fig. 3 Incidentally detected solid, renal mass in the posterior part of the left kidney (*arrow*). Subsequent surgical removal showed oncocytoma

6–12 min post-contrast scan, providing a combined nephrographic and excretory phase (Chow et al. 2007).

5.2 Benign Renal Lesions

As mentioned above, in most cases, benign renal neoplasms cannot reliably be differentiated from malignant ones on non-contrast- or contrast-enhanced CT. Thus, oncocytomas, which are benign, may simulate renal cancer on CT (Fig. 3), and even at biopsy, it may sometimes be impossible to differentiate the two. Many of these tumors therefore go to surgery or percutaneous ablation without a definite diagnosis but with the chance of being malignant in 85–90% of the cases. All incidentally detected solid tumors in the kidneys should thus be considered potentially malignant and be fully investigated as such. One exception, however, is renal angiomyolipoma (AML), which is a benign tumor containing vascular, muscular, and fatty tissue components in varying proportions. In most cases, the fatty component is dominant or at least abundant enough to make it readily identifiable on non-contrast-enhanced CT (Fig. 4). Identification of macroscopic fatty components in regions of interest (density below −10 HU and preferably

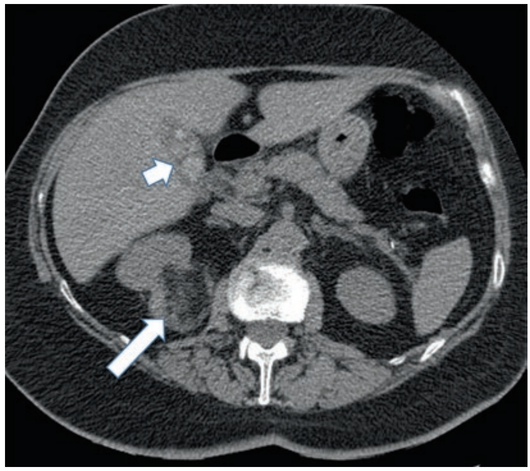

Fig. 4 Angiomyolipoma (AML) in the posterior part of the right kidney (*long arrow*), incidentally detected on acute non-enhanced abdominal CT in a 75-year-old woman with abdominal pain. The fatty components (mean − 45 HU) are characteristic for AML. The maximum diameter of the lesion was 7 cm, and due to the risk of spontaneous bleeding, the lesion was embolized. Note also faintly calcified stones in the normal-sized gallbladder (*short arrow*)

lower) is virtually diagnostic of AML (Jinzaki et al. 2014). Although these tumors are benign, they may occasionally show (benign) involvement of local lymph nodes. As most AMLs are asymptomatic, they are usually detected incidentally. Although these tumors are commonly clinically silent, with growth, there is a risk of bleeding, which may be acute and severe. Therefore, if an AML is 4 cm or larger, preventive embolization, ablation, or surgical removal is often considered. This means that incidentally detected AMLs smaller than 4 cm should be followed up in order to estimate their growth potential. Such follow-up is best performed with CT or MRI, which provide more reproducible size measurements than ultrasonography.

Occasionally, the fatty component of an AML is minimal and not readily identifiable on CT. Although fatty components may be identified by analysis on pixel level, such “fat-poor” AMLs may simulate renal cell carcinoma. Fat-poor angiomyolipomas may be hyperattenuating relative to renal parenchyma on non-enhanced CT with density measurements >45 HU, or, rarely isoattenuating and contrast enhancing, similar to some renal cell carcinomas. In questionable cases, MRI may be of help to demonstrate or rule out a fatty component (Jinzaki et al. 2014). Renal cancers do not exhibit fatty content, unless the tumor engulfs normal fatty tissue in the renal sinus, which has been described in rare cases.

If angiomyolipomas are detected at a young age, or if large, multiple, or bilateral, tuberous sclerosis should be suspected, as angiomyolipomas develop in over half of patients with tuberous sclerosis. Angiomyolipomas in patients with tuberous sclerosis seem to grow faster and may be more prone to bleeding and may therefore need treatment, including mTOR inhibitors, in a higher proportion than sporadic angiomyolipomas (Jinzaki et al. 2014).

5.3 Small Lesions

The risk of a solid renal mass lesion being malignant increases with the size of the lesion (Thompson et al. 2009). As pointed out above, solid renal masses tend to be small when detected incidentally. However, it is uncertain to what extent really small renal lesions (<1 cm) are reported by radiologists. Some subcentimeter lesions visually stand out as clearly low density compared to the surrounding enhancing parenchyma, suggesting a cystic character. However, objective measurements of density (HU numbers), to confirm cystic or solid nature of such small lesions, are problematic. This may be related to technical factors such as slice thickness, kilovoltage and amperage settings, contrast medium dose and timing, partial volume effects, and particularly pseudoenhancement due to beam hardening. Pseudoenhancement is more prone to occur with small (<1.5 cm) and centrally located lesions surrounded by contrast-enhancing renal parenchyma, while it is less apparent in larger lesions and in lesions with peripheral location (Tappouni et al. 2012; Patel et al. 2014). The risk of misinterpreting the nature of small renal lesions due to these factors should thus be considered. Commonly, 15 HU or even 10 HU increase in density after intravenous contrast injection, as compared to the native series, has been used to classify lesions as enhancing, thereby calling them solid. However, there is no consensus regarding the optimal cutoff, and lately even 15–20 HU enhancement has been considered indeterminate. In a recent study, the post-contrast-enhancement pattern in 137 verified solid renal tumors (85% malignant and 15% benign) measuring 1.0–3.9 cm (median 2.4 cm) was analyzed (Al Harbi et al. 2016). Using 15 HU post-contrast enhancement to define a mass as solid, 17% of the malignant lesions did not reach the threshold in the corticomedullary phase, 8% did not reach the threshold in the nephrographic phase, and 3% did not reach the threshold in both the corticomedullary and the nephrographic phases. Using 20 HU as the threshold, 21% of the malignant lesions did not reach the threshold in the corticomedullary phase, 12% did not reach the threshold in the nephrographic phase, and 9% did not reach the threshold in both phases. In particular, papillary cancers did not reach the 15 HU or 20 HU threshold in over half of the cases in the corticomedullary phase, while the corresponding figures in the nephrographic phase were 18% (15 HU threshold) and 32% (20 HU threshold). About a third of the chromophobe cancers did not reach the thresholds in any phase. Even the clear-cell cancers did not reach the 15 HU threshold in 11% (corticomedullary phase) and 7% (nephrographic phase), while the combination of corticomedullary and nephrographic phases reduced the proportion of clear-cell cancers not reaching the 15 HU and 20 HU thresholds to 5% and 6%, respectively. All of the benign lesions had post-contrast enhancement exceeding both thresholds in all phases (Al Harbi et al. 2016). It can be concluded that applying the 15 HU or 20 HU threshold on both the corticomedullary and nephrographic phases results in the best sensitivity for classifying a lesion as solid or not. Even so, benign and malignant renal tumors in most cases cannot be reliably separated on the basis of their enhancement pattern. Although most small renal cancers enhance above these thresholds with a wide margin, the fact that some do not enhance above 15 HU or 20 HU may pose a problem to differentiate e.g. a hyperdense cyst from a solid tumor. For indeterminate lesions, contrast-enhanced ultrasound or MRI should therefore be considered for problem-solving.

Lesion enhancement after contrast medium administration is a cornerstone in the differentiation between solid and cystic lesions, but other factors such as lesion demarcation, homogeneity, and occurrence of necrosis and calcifications must be taken into consideration. Reporting and decision-making must also take the clinical situation, especially the age of the patient and comorbidity, as well as the potential tumor growth potential, into consideration in order to avoid false-positive cases leading to unnecessary further examinations. If a subcentimeter lesion does not show any obvious malignant characteristics but is too small to characterize further by imaging, it is comforting that such small lesions are very unlikely to be malignant at the time (Berland et al. 2010). Even if a 1-cm renal tumor is malignant, it is very unlikely to have metastases at presentation (Thompson et al. 2009). Unless the patient is young and has a genetic risk or renal tumor is specifically searched for (which is not the case with an incidental finding), aggressive follow-up for further characterization of subcentimeter lesions is not generally recommended (Hindman 2015).

5.4 Cystic Renal Lesions

It is commonly stated that simple renal cysts occur in 50% of individuals over 50 years of age, based on autopsy findings. On abdominal CT, benign renal cysts are one of the commonest incidental findings (Carrim and Murchison 2003). There is a clear increase in the frequency and number of renal cysts with increasing age. Thus, cysts are rarely present under the age of 40 years (found in 8% of the patients), while it was found in 61% of patients aged over 80 years (Carrim and Murchison 2003). If multiple renal cysts occur in patients under 40 years of age, it may be indicative of autosomal dominant polycystic kidney disease (ADPKD) (see below). As simple renal cysts virtually always are symptom-free, they are nearly always incidental findings. Very rarely a large simple cyst may be suspected to cause pain or discomfort, and in such exceptional cases, a diagnostic percutaneous puncture and emptying of the cyst fluid may show if the cyst is the cause of the problem. After such drainage, the cyst usually refills in a short time, so if symptomatic and needing treatment, the cyst could be treated by surgical de-roofing.

The challenge for the radiologist when evaluating renal cyst-like lesions is to differentiate simple, benign cysts from atypical complex cysts and cystic tumors, which may require additional imaging or follow-up.

5.5 Simple Cysts

Benign simple cysts are characterized by a round or oval shape, low-density, homogeneous fluid content typically measuring <20 Hounsfield units (HU), and thin wall. After IV contrast injection, they should remain low in density, with less than 10–15 HU increase. However, one must consider that pseudoenhancement may occur, as discussed above. Most incidentally detected renal cysts can be easily dismissed on contrast-enhanced CT, based on the criteria above. A cyst which is well demarcated, thin walled, of low, homogeneous density, and without septa, solid parts, or calcifications should be called and reported as a benign cyst and does not require follow-up, regardless of the size of the cyst.

Renal cysts of benign appearance may also occur with a number of underlying specific disorders, which may be incidentally encountered on abdominal CT performed for various reasons. In patients on long-standing lithium therapy, renal dysfunction may develop, including a large number of small (1–2 mm), bilateral, cortical, and medullary “microcysts” in normally sized kidneys (Wood et al. 2015). Another cause of acquired cysts is end-stage renal disease and dialysis, which commonly are associated with the development of renal cysts (defined as at least three cysts in each kidney, usually in small, atrophic kidneys). This type of acquired cystic kidney disease is associated with occasional cyst bleeding and an increased risk of renal cancer development (Katabathina et al. 2010).

Occasionally, an unexpectedly large number of renal cysts in normal sized or enlarged kidneys are incidentally noted on abdominal CT. If this occurs in young or middle-aged patients, it may indicate autosomal dominant polycystic kidney disease (ADPKD). This is characterized by enlarged kidneys with multiple bilateral renal cysts, which develop and increase in number and size with age (Pei et al. 2015). The multitude of bilateral renal cysts may be accompanied by liver cysts, sometimes causing a considerable mass effect and occasionally pancreatic and other cysts (Kim et al. 2015). As the disorder is familial, most patients are aware of their potential disease at an early stage, but sometimes the diagnosis is first suspected at cross-sectional imaging in young or middle-aged adults, by incidental detection of multiple renal cysts. Normally, renal cysts are rarely detected in individuals under 30 years of age. APKD should be suspected if three or more cysts are found in one (or both) kidneys in patients under 40 years of age, two or more cysts in each kidney in patients 40–59 years, or four or more cysts in each kidney in patients aged 60 or more (Pei et al. 2009).

5.6 Complex Cysts

Cysts which do not fulfill the criteria for simple cysts are called complex cysts. These constitute a considerable part of incidentally detected cysts and cause considerable concern for radiologists and clinicians. Complex cysts are characterized by one or several of the following features: higher than expected density for a simple cyst (>20 HU), localized or global wall thickening, and internal septations, calcifications, or a solid component in a predominantly cystic lesion. Complex cysts may be entirely benign, but at the other end of the spectrum are cystic malignant tumors and cyst-like necrosis in malignant tumors. These latter cystic lesions may be easy to identify when they contain a clearly solid, contrast-enhancing component, and the concern is mainly about those that exhibit some of the above features, without convincing evidence of malignancy.

Fig. 5 Incidental detection of a 12 mm hyperdense exophytic renal lesion with homogeneous density of 67 HU on non-enhanced CT. After intravenous contrast injection, the density was unchanged. The finding is characteristic for cyst with high-protein content (hemorrhagic cyst)

One variant of complex cyst often detected incidentally is the protein-rich or hemorrhagic cyst (Fig. 5). These are cysts of high, homogeneous density above 20 HU on non-enhanced CT, without significant increase (<15 HU) in density after intravenous contrast administration and without any other features of complex cysts (i.e. absence of calcifications, septations, wall thickening, and solid components). As with any HU cutoff, there is overlap between normal and abnormal cyst density, variations depending on the choice of image slice and size and placement of the region of interest (ROI) as well as inherent variations between CT machines (Hammarstedt et al. 2013). As discussed above, HU cutoffs should be considered as rule of thumbs to be applied sensibly, taking all imaging characteristics into consideration.

Cysts may be rich in protein due to bleeding or infection, although the etiology cannot be proven in most cases. For example, in autosomal dominant polycystic kidney disease with a large number of cysts, the conversion of simple cysts to high-density cysts from one examination to another is not unusual. This is frequently interpreted as cyst bleeding, which usually is symptom-free, although it may occasionally be associated with pain. If a hyperdense renal lesion is incidentally detected on non-contrast-enhanced CT, differentiation between a hemorrhagic cyst and solid tumor should be affirmed by contrast-enhanced CT, MRI, or ultrasonography.

5.7 Bosniak Classification

Incidentally detected cysts which exhibit features of complexity are best classified by the Bosniak classification system. Originally presented in 1986 (Bosniak 1986), this system allows categorization of renal cysts according to the degree of complexity (Bosniak I–IV) and also provides recommendations on follow-up. Because of difficulties in separating Bosniak II and III, an additional category, Bosniak IIf (f for follow-up), was added (Israel and Bosniak 2003). The categorization is based on the cyst fluid density, post-contrast enhancement characteristics, degree of wall thickness, occurrence of internal septations and calcifications, and enhancing soft tissue nodules. A simple cyst is classified as Bosniak I if of water density, not contrast-enhancing, thin walled, and without septations, calcifications, or solid components (Fig. 6). Bosniak II cysts are characterized by "a few hairline-thin septa, fine calcification, or a short segment of slightly thickened calcification present in the wall or septa (Fig. 6). Uniformly, high-attenuation lesions (<3 cm) that are sharply marginated and do not enhance are included in this group." Bosniak II cysts are also considered to be benign. Bosniak IIf cysts exhibit somewhat more complexity: "These cysts may contain an increased number of hairline-thin septa. Minimal enhancement of a hairline-thin smooth septum or wall can be seen, and there may be minimal thickening of the septa or wall. The cyst may contain calcification that may be thick and nodular, but no contrast enhancement is present. There are no enhancing soft-tissue components. Totally intrarenal nonenhancing high-attenuation renal lesions that are 3 cm or larger are also included in this category. These lesions are generally well marginated." The recommendation for Bosniak IIf is to follow these lesions and to determine change in size or character.

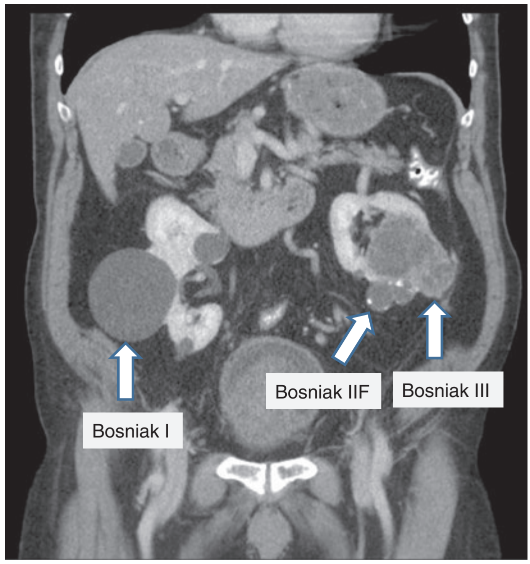

Fig. 6 Examples of Bosniak I, IIF, and III classification of cystic renal lesions. Note the solid, contrast-enhancing elements of the Bosniak III lesion. As additional incidental finding, a mass in the bladder, suggestive of enlarged prostate, is noted

Bosniak III cysts are defined as follows: "These lesions are indeterminate cystic masses that have thickened irregular walls or septa in which enhancement can be seen." Bosniak IV: "These lesions are clearly malignant cystic masses that not only have all the characteristics of category III lesions, but also contain enhancing soft-tissue components adjacent to but independent of the wall or septa" (Israel and Bosniak 2003) (Fig. 6).

It may be difficult to understand the details of the Bosniak classification by just reading the definitions. The classification system is better understood by looking at the clinical case illustrations presented in Bosniak's own original articles (Bosniak 1986, Israel and Bosniak 2003). Although not perfect in its prediction of malignant development, the Bosniak classification system offers a good help when complex cysts are incidentally encountered, including advice on follow-up. Decision on follow-up recommendations should be based on the Bosniak classification, but the patient comorbidity, age, and patient's own preferences must also be taken into consideration.

5.8 Renal Calcifications

Incidental renal calcifications are common, especially in the elderly. On unenhanced CT, even very small calcifications (1–2 mm) are easy to detect. When encountering a renal calcification, the following question should be asked: Does the calcification represent a urinary stone (located in a calyx, the renal pelvis, or ureter), a parenchymal calcification, or a vascular calcification? Vascular (arterial) calcifications are usually easy to identify by their location close to the renal hilum and in the course of the renal artery, and the finding may be supported by the coexistence of other vascular calcifications suggesting generalized atherosclerosis. In older patients with generalized vascular calcifications, renovascular calcifications are not commonly reported by the radiologist, as vascular calcifications can be considered as part of normal aging. However, in young patients, and in older patients with advanced calcifications, it might be worthwhile to report, as it may be related to treatable renal artery stenosis and renovascular hypertension (Glodny et al. 2012).

It may sometimes be difficult to differentiate a parenchymal calcification from a stone in the collecting system on non-enhanced CT and on CT obtained in the cortical or nephrographic phase, when there is not yet contrast medium filling of the collecting system, making it difficult to outline. This is rarely a problem in the excretory phase, when the collecting system is well depicted, although urinary stones may be hidden in the contrast-filled collecting system. Parenchymal calcifications are relatively rare and may be related to, e.g., nephrocalcinosis, tubular necrosis, tuberculosis, or other infections and sometimes to renal carcinoma. In case of tuberculosis, however, there are usually other typical manifestations such as corresponding parenchymal thinning and calyceal strictures and dilatation or tuberculosis manifestations in other organs. With renal carcinoma, calcifications rarely occur in small tumors, while larger calcified tumors usually are evident by their space-occupying characteristics.

Any calcifications suspected to be stones located in the collecting system should be reported, as they may potentially be displaced to the ureter causing obstruction. Even if small and not likely to cause pain or obstruction when located in a calyx, they may be of importance. Thus, they may increase in size with time, and the patient may benefit from early detection, follow-up, and perhaps treatment with extracorporeal shock wave lithotripsy (ESWL).

5.9 False-Positive Renal Masses

Focal compensatory hypertrophy associated with post-pyelonephritic parenchymal scar formation may sometimes simulate a renal mass lesion, although scar formation is more often associated with parenchymal atrophy, rather than giving an impression of mass lesion. As scar formation is a long-term effect of previous acute infection, scars may be encountered in symptom-free patients as incidental finding on CT. If in doubt, calyceal clubbing corresponding to the site of parenchymal scar formation should be looked for, to support post-pyelonephritic scarring, which is also characterized by multifocal, asymmetrical distribution in the kidney. This is different from persisting fetal lobulation, where smooth indentations of the renal outline are seen not opposite but between the pyramids. Another potential pitfall is hypertrophy of a column of Bertin, a normal variant occasionally interpreted as a renal tumor. A column of Bertin (columna renalis) represents normal cortical tissue extending deep into the kidney from the peripheral cortex, having exactly the same post-contrast attenuation as the rest of the renal cortex (Ramanathan et al. 2016).

5.10 Renal Size

The size of the kidneys should always be assessed, taking normal parenchymal thinning with age into consideration, and discrepancies in size of the two kidneys should be mentioned in the radiology report.

5.11 Normal Variants and Malformations

Among other clinically relevant incidental findings on abdominal CT, normal variants and malformations of potential clinical importance should be mentioned. Thus, congenital absence of a kidney or status post nephrectomy (single kidney) should be documented, as it may otherwise lead to confusion if the patient later undergoes, e.g., abdominal ultrasonography. Also, this information is of clinical value because of the risk of hyperfiltration and subsequent glomerulosclerosis that may occur after nephrectomy (Abdi et al. 2003). Likewise, duplication of the collecting system, ectopic and malrotated kidneys, and horseshoe kidney (Fig. 7) should be mentioned (Ramanathan et al. 2016). A horseshoe kidney is a renal fusion anomaly with functioning renal parenchyma or fibrotic tissue bridging the midline and the two renal units. Horseshoe kidneys usually have multiple renal arteries, sometimes originating from the distal aorta or iliac arteries, of importance in case of surgery or interventional procedures. Horseshoe kidneys occur in approximately 1/500 adults and are usually asymptomatic. However, they carry an increased risk for obstruction, infection, and stone formation, and it may be vulnerable in abdominal trauma. In some cases, horseshoe kidney can be linked to other malformations or a variety of genetic or other syndromes and to an increased risk of malignancy.

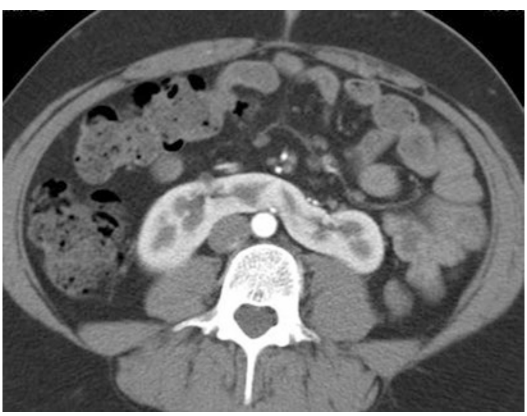

Fig. 7 Incidentally detected horseshoe kidney in a woman who had an arterial phase CT because of suspected aortic dissection. It was revealed that the patient had Turner's syndrome, which carries an increased risk of renal fusion anomaly (horseshoe kidney)

5.12 Hydronephrosis

Incidental detection of hydronephrosis and hydroureter, which may indicate urinary tract obstruction, should be mentioned. In such cases, it should be determined if it is uni- or bilateral, if it is associated with ureteral dilatation, and if it is associated with generalized parenchymal thinning, which suggests more long-standing obstruction. Although hydronephrosis is usually related to urinary obstruction, this is not always the case, as dilatation may remain permanently after removal of an obstruction, if the obstruction has been long-standing and the system thereby lost some of its elasticity. Hydronephrosis on the basis of obstruction is associated with dilatation of the renal pelvis as well as calyces. It should be differentiated from a normal but large extrarenal renal pelvis without calyceal dilatation, which is not indicative of obstruction. If the CT is done with IV contrast administration, the function of the parenchyma and, with delayed scan in the excretory phase, the urinary outflow may be assessed. Another pitfall on non-enhanced and early post-contrast scanning is the existence of peripelvic cysts, which also may simulate hydronephrosis. However, in the excretory phase, differentiation between hydronephrosis and a cluster of peripelvic cysts is usually straightforward (Fig. 8). Less commonly, a parapelvic cyst, i.e. an ordinary cyst originating from the renal parenchyma and extending into the renal sinus region, may be mistaken for hydronephrosis.

6 Urinary Bladder and Upper Urinary Tract Tumors

The urinary bladder has traditionally been the domain for the urologists, cystoscopy being the primary method for tumor detection. However, improved quality of CT allows detection of bladder tumors in many instances (Raman and Fishman 2014). The vast majority of patients

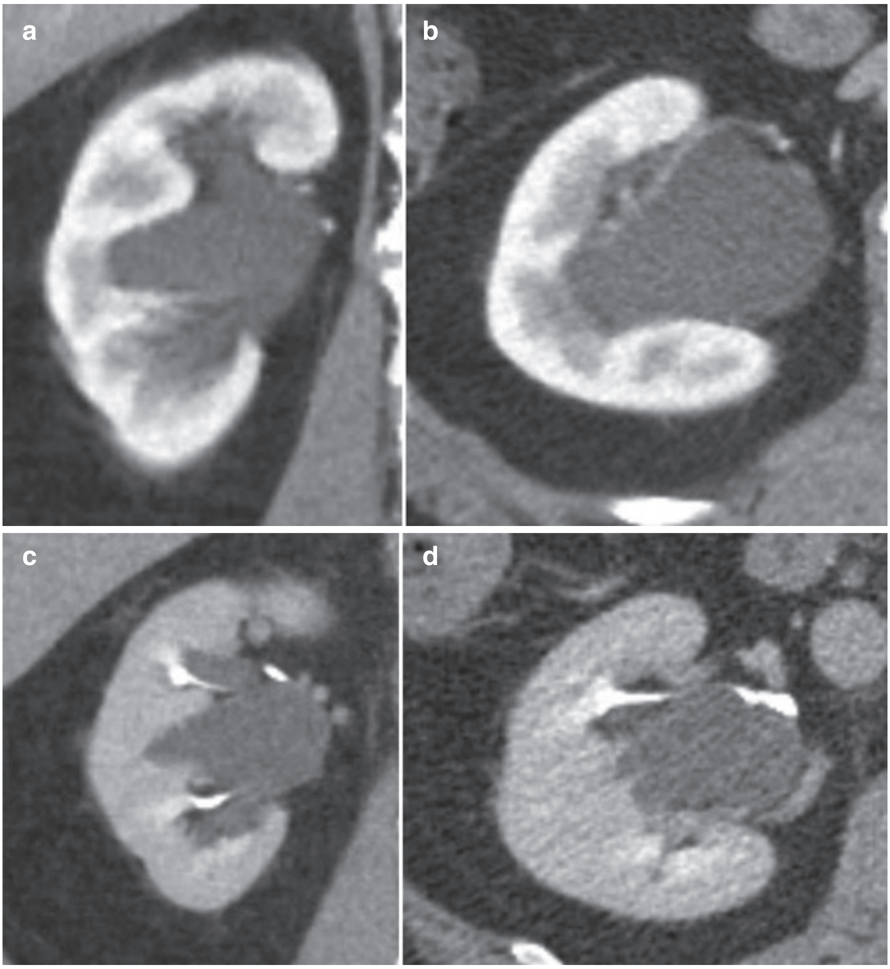

Fig. 8 Incidental finding suggestive of hydronephrosis on contrast-enhanced abdominal CT in the corticomedullary phase, before iodine contrast material arrives in the collecting system (*upper row*: coronal (**a**) and axial (**b**) planes, respectively). Images obtained a few minutes later (in the excretory phase) clearly show that the collecting system has normal width (*lower row*: coronal (**c**) and axial (**d**), respectively) and that the hypodense fluid-containing structures represent peripelvic cysts. Peripelvic cysts are not uncommon and are claimed to develop from lymphangiectasia, in contrast to parapelvic cysts which represent ordinary cysts protruding into the sinus region

with bladder or upper urinary tract cancer present with hematuria, and the workup includes cystoscopy and CT urography. The frequency of incidentally detected bladder and upper urinary tract cancers is largely unknown but appears to be low.

Unless grossly space occupying, bladder tumors are best visualized in the corticomedullary phase, as compared to the nephrographic and excretory phases (Helenius et al. 2016), due to their high attenuation in the arterial phase. As early detection of bladder cancer may improve prognosis, the bladder should routinely be scrutinized for incidental tumor detection, especially in middle-aged and older individuals, having in mind the better chance of tumor detection on contrast-enhanced CT series. Nevertheless, many bladder tumors can be depicted also on non-enhanced CT (Fig. 9).

Tumors of the calyces, renal pelvis, and ureters are much less common than urothelial bladder tumors, representing about one tenth of the total number of urothelial tumors. Thus, they are relatively rare tumors, not commonly detected as incidental findings. Typical findings

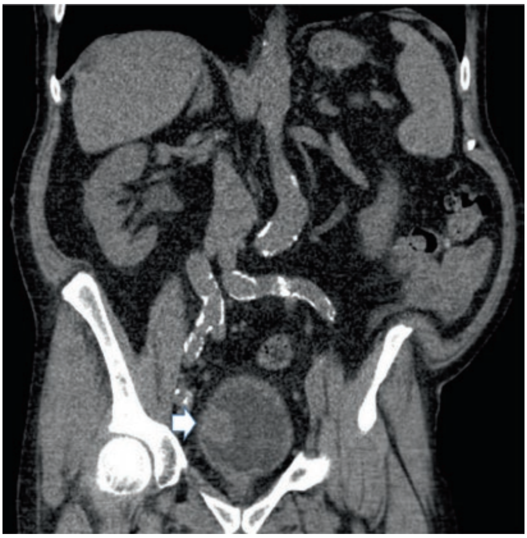

Fig. 9 Two centimeter rounded bladder wall tumor (*arrow*), hyperdense relative to the urine and protruding into the bladder lumen, on non-enhanced CT

at careful assessment of the collecting system and ureters are wall-thickening and contrast-filling defects on images obtained in the excretory phase, with or without dilatation depending on the degree of outflow obstruction (Xu et al. 2010). The nephrographic phase has been shown to demonstrate upper urinary tract tumors in a higher frequency compared to the excretory phase (Metser et al. 2012), but the combination of the two provides a better diagnostic accuracy. However, as for bladder cancer, the best possibility for incidental detection of upper urinary tract tumors appears to be in the corticomedullary or arterial phase.

7 Adrenals

Adrenal masses are among the most common incidental findings on CT of the abdomen. Hammarstedt et al. found a frequency of 4.5% in a reevaluation of 3,801 unselected clinical abdominal CT examinations, from a cohort of over 30,000 CT examinations (Hammarstedt et al. 2010). The same study showed a considerable variation in the frequency of reported lesions between hospitals (range 1.8–7.1%), suggesting considerable under-reporting in clinical practice, although differences in patient population profiles and other factors also may be a factor. The frequency of adrenal incidentalomas increases with age. Figures from autopsy studies suggest figures in the range of 7–8% (Abecassis et al. 1985) or even higher in the elderly, depending on diagnostic criteria used and the age and character of the studied populations. The vast majority of adrenal incidentalomas are non-hyperfunctioning adenomas, but the task of the radiologist is to determine, with reasonable certainty, if the lesion is a benign adenoma, cyst or other benign lesions, or malignant primary or metastatic tumor.

When an unexpected adrenal lesion is identified on CT, three questions should be raised: First, does the patient have a known malignancy? Second, does the lesion have benign, indeterminate, or malignant CT characteristics? Third, is the lesion hyperfunctioning or not?

The first question – does the patient have a known malignancy – is very relevant as the risk of an incidentally detected adrenal mass being malignant is very low if the patient has no known malignancy. Thus, Song et al. (2008) found no case of malignant adrenal lesion in 1,049 adrenal incidentalomas in patients without malignant disease. In a patient with known malignancy, on the other hand, an adrenal mass may represent a metastasis or an unrelated benign lesion. In patients with a previous history of extra-adrenal malignancy, incidentally detected adrenal lesions were found to be benign in 74% of the cases. In patients with concurrent extra-adrenal malignancy without metastases, the adrenal lesion was benign in 53%, and in patients with extra-adrenal malignancy with metastases, the adrenal lesion was benign in 25% of the cases (Hammarstedt et al. 2012). Thus, an adrenal lesion in a patient with a malignancy should not automatically be taken for a metastasis, especially in a situation where it is the only suspected metastatic site, as the existence of a metastasis may change treatment dramatically.

The second question – does the lesion have benign, indeterminate, or malignant CT characteristics – can ideally be answered already at the time of detection, if the CT examination includes

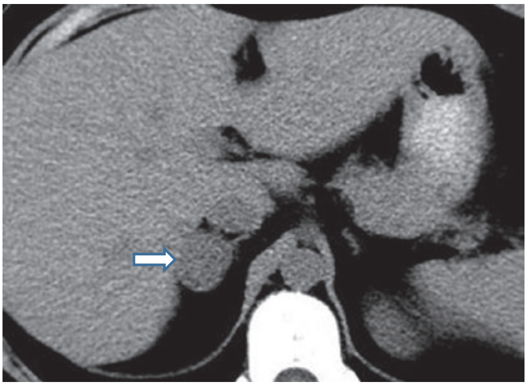

Fig. 10 Non-enhanced abdominal CT showed an incidental right-sided, oval-shaped, well-demarcated, homogeneous adrenal mass (*arrow*), with low density (5–7 HU). This suggests high lipid content characteristic of adrenal adenoma. In the absence of extra-adrenal malignancy, the risk that it is a malignant lesion is very small

a non-contrast-enhanced series. This is based on the size, morphology, and attenuation measurements of the lesion. It has been shown that adrenal lesions which are homogeneous, well defined with regular outlines, and have a density of 10 HU or less on native images (without contrast medium administration) can confidently be classified as benign (Fig. 10). This density value has also been accepted as a reasonable cutoff in the recently published guidelines from the European Society of Endocrinology (Fassnacht et al. 2016), based on a systematic review and meta-analysis of the literature (Dinnes et al. 2016). Some lesions with ≤10 HU are benign cysts or myelolipomas (Fig. 11), with low density due to their fluid or fatty content, respectively. Myelolipomas are mixed tumors from fatty and myelopoietic cells and are characterized by areas of macroscopic fat, easily identifiable on CT (mean density − 70 HU). They are not hormone producing and therefore usually asymptomatic, unless very big (Lattin et al. 2014). The majority of benign adrenal lesions are, however, adenomas. Most adenomas are rich in intracytoplasmic lipid, which explains the low-density values (≤10 HU). A minority of adenomas are lipid poor, with density measurements >10 HU, partly overlapping with malignant lesions which are also lipid poor.

Fig. 11 Incidental finding of right adrenal mass with multiple well-defined components of macroscopic fat. The finding is typical for benign adrenal myelolipoma

However, malignant lesions often have other characteristics, such as irregular outlines, necrosis, and uneven parenchymal contrast enhancement. Contrast medium washout calculation on CT has been suggested to separate benign from malignant adrenal lesions, when native density measurements are indeterminate, i.e. >10 HU. Absolute washout measurements require that CT scans are obtained before intravenous contrast administration, during the portal phase, and after 10 or 15 min, while relative washout can be calculated on early- and delayed-phase contrast-enhanced images.

Using 60–75 s delay for early contrast enhancement scan and 15 min for delayed scan, a washout of 60% or more is a characteristic for benign adenoma. However, according to a recent meta-analysis, the scientific evidence is not sufficient to motivate washout calculations for regular use for differentiating malignant from benign incidentalomas (Dinnes et al. 2016; Fassnacht et al. 2016).

The third question – is the lesion hyperfunctioning or not – cannot be answered based on its imaging appearance. Each patient with a newly discovered adrenal incidentaloma should be checked for hormonal overproduction of cortisol, aldosterone, or adrenalin/noradrenalin, by deepened clinical history, physical examination, and hormonal laboratory test (Lattin et al. 2014). This is the responsibility of the referring clinician, but the radiologist can point out the need of hormonal testing in his/her report.

7.1 Shape and Size of Adrenals

Identifying adrenal masses may be difficult as the shape and size of the adrenals differ between individuals and between the right and left side within the patient. Vincent et al. (1994) presented CT-based normal values for the size of the adrenal limbs and adrenal body on the right and left side, which may be of some help. The maximum width of the adrenal body was 6.1 mm and 7.9 mm on the right and left side, respectively; the maximum width of the right and left medial limbs were 2.8 mm and 3.3 mm, respectively; and the width of the lateral limb was 2.8 mm and 3.0 mm, respectively. More useful, though, is to look for any localized mass that alters the outline of the adrenal.

The ESE-ENSAT guidelines (Fassnacht et al. 2016) concern only incidentalomas measuring 1 cm or more in size, and workup or follow-up is recommended only if the lesion is 1 cm or more, unless clinical signs and symptoms suggest hormonal overproduction. It is acknowledged that this cutoff is arbitrary, based on the difficulties to confidently identify, measure, and characterize subcentimeter lesions and considering the variations in size and shape of the adrenal. Nevertheless, it should be recognized that even subcentimeter nodules may be hormonally active.

7.2 Management of Adrenal Incidentalomas

Until recently, workup and follow-up of adrenal incidentalomas have been quite extensive, including repeated CT examinations for up to 2 years with and without contrast medium administration to ensure a benign course. With increasing knowledge that adrenal incidentalomas in patients without malignancy very rarely are, or become, malignant, these investigational programs have now been shortened substantially for many patients. For those with indeterminate imaging findings and those with evidence of hormone excess, multidisciplinary expert team meetings are recommended in new guidelines (Fassnacht et al. 2016).

Patients without known extra-adrenal malignancy: non-enhanced CT is recommended for classifying an adrenal lesion as benign or indeterminate. A benign-appearing, well-defined, homogeneous lesion measuring <4 cm and with density ≤10 HU should be considered benign and needs no follow-up. However, evaluation for hormonal excess should be performed. If a similar lesion is 4 cm or larger, it is still likely to be benign, but due to lack of scientific evidence, follow-up with unenhanced CT after 6–12 months for size assessment is recommended. Size (largest diameter) increase of 20% and at least 5 mm is considered suspicious for malignancy and possible indication for surgery.

A patient without known extra-adrenal malignancy and an incidental adrenal mass with indeterminate density characteristics (>10 HU on non-enhanced CT) but otherwise benign appearance, should have non-enhanced CT in 6-12 months for growth assessment. If, on the other hand, the imaging findings do not support a benign etiology (heterogeneous, ill-defined or large lesion), if growth occurs, or if there is hormone overproduction, the patient may be a candidate for surgery. The decision should ideally be taken in a multidisciplinary team, taking clinical circumstances and patient preferences into account (Fassnacht et al 2016). With MRI, the differentiation between benign and malignant lesions is best done using chemical shift technique. Due to its rich lipid content, benign adenomas usually demonstrate a reduction in signal intensity on out-of-phase images, while the signal intensity of lipid-poor adenomas and malignant lesions remains unchanged on in-phase and out-of-phase images. Unlike CT which provides absolute measurements of density, MRI can provide only relative measures of signal intensity. Visual assessment of the MRI signal drop appears to be as useful as these measurements. However, the evidence base for chemical shift evaluation is weak, and CT is recommended as first choice, except in young patients and pregnant women.

7.3 Patients with a History of Extra-Adrenal Malignancy

If the adrenal lesion fulfills the criteria for benign etiology on non-contrast CT, it should be considered benign and requires no follow-up. If the lesion is indeterminate on non-enhanced CT, biopsy, PET-CT, or surgical resection can be considered to rule out metastasis. Regarding biopsy, it must be preceded by hormonal analysis to rule out pheochromocytoma, as the biopsy may release catecholamines causing severe symptoms.

7.4 Young Patients with Adrenal Incidentaloma

In patients under 40 years of age, the likelihood that an adrenal lesion is malignant is higher than in older patients. Therefore, immediate assessment and management rather than 6–12 months follow-up are recommended (Fassnacht et al. 2016).

8 Liver

Simple cysts, hemangiomas, and focal nodular hyperplasia are the most common hepatic lesions detected incidentally. Solid, malignant liver tumors are uncommon as incidental findings in patients without extrahepatic malignancy. In a large CT colonography screening study for colorectal cancer in nearly 8,000 asymptomatic individuals with a mean age of 57 years, unexpected extracolonic findings were analyzed on the unenhanced CT examinations (Pooler et al. 2016a, b). Individuals with extracolonic findings classified on CT colonography as C-RADS category E3 or E4 (Zalis et al. 2005), i.e. likely unimportant but incompletely characterized extracolonic findings (E3) or potentially important extracolonic findings (E4), were followed for 2–10 years. It is notable that all E3 (Pooler et al. 2016a) and E4 (Pooler et al. 2016b) liver masses in patients without known malignancy or cirrhosis were found to be benign liver cysts or cavernous hemangiomas on follow-up. It is thus comforting that incidentally detected isolated liver lesions on CT examinations very rarely seem to represent malignancy, providing that the patient has no known malignant disease or known underlying liver disease. Nevertheless, any solid-appearing liver lesion detected incidentally should be fully characterized by multiphase CT (if not obtained at detection), MRI, or contrast-enhanced ultrasonography. Solid-appearing liver lesions should be clearly highlighted in the radiology report, as underlying malignancy may be unknown to the radiologist. Also, even if benign, adenomas, focal nodular hyperplasia, and other solid liver lesions may be of clinical importance, causing symptoms and requiring intervention in some patients.

8.1 Cystic Lesions

Simple liver cysts are benign lesions without malignant potential and need no follow-up when identified incidentally on abdominal CT examinations. In autopsy studies, liver cysts have been demonstrated in up to half of patients without malignant disease. Benign liver cysts are characterized on CT as other benign, simple cysts, i.e. they are rounded or oval shaped with a thin wall and homogeneous, low density, water-like content (<20 HU) which does not enhance after intravascular contrast medium administration. Cysts that are difficult to characterize on non-enhanced CT are usually easy to confirm on contrast-enhanced CT, unless subcentimeter in size. In doubtful cases, contrast-enhanced ultrasonography, and in particular MRI, may be used for problem-solving. If multiple liver cysts are identified, the kidneys and pancreas should be scrutinized for additional cysts as part of autosomal dominant polycystic kidney disease, which occasionally occurs as an incidental finding in young- or middle-aged patients, although most of such cases are known from family history (Kim et al. 2015).

Any unclear cystic lesion that does not fulfill the CT criteria for a simple cyst, i.e. those that are multilocular or have a thick or irregular wall, septations, solid components, or suspicious contrast enhancement, should be suspected for malignancy and further characterized with ultrasonography or MRI. Such cystic lesions may represent a wide range of etiologies, including biliary cystadenoma or cystadenocarcinoma, cystic degeneration of hepatocellular cancer, and metastasis from ovarian carcinoma and a range of benign disorders, such as biloma, abscess, or echinococcal cysts (Qian et al. 2013). Most of these conditions are, however, unlikely to be incidental findings as they are commonly associated with symptoms. One exception is echinococcal (hydatid) disease, which may be encountered incidentally, as symptoms may develop slowly. Although not encountered commonly as an incidental finding, increasing international migration from endemic areas makes it an important differential diagnosis also in non-endemic countries. Echinococcal disease is caused by the larval stage of the *Echinococcus granulosus* or multilocularis tapeworm, by ingestion of eggs of the parasite transmitted from animals to humans. Echinococcus disease is endemic in large parts of the world. The ingested eggs release oncospheres which penetrate the gastrointestinal tract to the portal system and invade the liver parenchyma, causing characteristic cystic lesions. These may become symptomatic when large enough to compress the biliary tree or portal vessels, causing jaundice or portal hypertension, or by rupture into surrounding tissues or spaces (Alghofaily et al. 2016). Although the liver is the most common location for echinococcal disease, echinococcal cysts may be seen in virtually any organ. The typical appearance is that of liver cysts containing so-called daughter cysts, i.e. cysts within a mother cyst, sometimes with wall enhancement. The cyst walls, and detached floating membranes, may give the impression of septations. Commonly, characteristic calcifications of the cyst walls occur (Marrone et al. 2012).

8.2 Hemangioma

Hemangiomas are the most common non-cystic focal liver lesions, occurring in about 20% in autopsy series. As these lesions are mostly asymptomatic, it is a common incidental liver finding. The reported frequency of hemangiomas may be higher on MRI (7%) than on CT, where the prevalence on abdominal CT was 2.4% in a recent retrospective analysis of 70,000 abdominal CT examinations (85% incidental) (Mocchegiani et al. 2016). These are minimum figures, considering the retrospective design of the study. On non-enhanced CT, the most common type of hemangioma, the cavernous hemangioma, has attenuation similar to that of other vascular structures and may therefore be difficult to characterize. After intravenous contrast medium injection, hemangiomas appear well defined, with nodular, peripheral-enhanced vascular structures becoming apparent, surrounding the low-attenuating center, followed by gradual centripetal contrast medium fill-in, which typically will be noted over several minutes until more or less complete fill-in will occur (Fig. 12). In most cases, hemangiomas can be confidently diagnosed on contrast-enhanced CT. Normally, hemangiomas are asymptomatic and require no further follow-up (Marrero et al. 2014). However, if large (>4 cm), there is a risk, albeit small, of spontaneous rupture that may motivate follow-

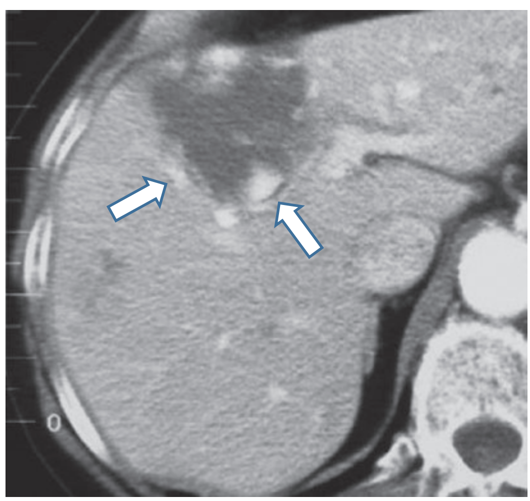

Fig. 12 Incidental detection of a low density liver lesion with nodular peripheral contrast enhancement (*arrows*) on early phase contrast-enhanced CT. The finding is highly suggestive of hemangioma, which can be confirmed by progressive centripetal contrast fill-in on a later phase imaging

up and possible intervention (Mocchegiani et al. 2016). Considering that rupture occurred mainly in large lesions with a peripheral location, the size and location of the hemangioma should be clearly stated in the radiology report. If an hemangioma is incidentally suspected on non-enhanced CT, the lesion, like other lesions that do not fulfill the criteria for simple cysts, should be further characterized by contrast-enhanced CT or MRI, if necessary including delayed imaging to confirm a hemangioma. Heavily T2-weighetd MRI is particularly effective to differentiate hemangioma from a malignant lesion (McFarland et al. 1994). As an alternative, contrast-enhanced ultrasound may be used, providing that a trained examiner is available (D'Onofrio et al. 2015).

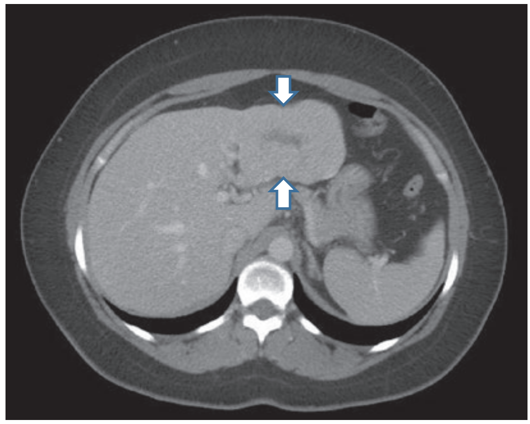

Fig. 13 A 32-year-old, previously healthy female with acute lower abdominal pain admitted for acute abdominal CT, which showed acute appendicitis. As incidental finding, a 7 × 6 cm solid, slightly lobulated lesion of the left lobe of the liver was found. The lesion appeared isoattenuating with the liver in the portal phase (*arrows*) and showed a central scar suggestive of, but not proving, focal nodular hyperplasia (FNH). It could not be confidently classified on single-phase CT, but FNH was confirmed by subsequent liver MRI

8.3 Non-cystic Benign Liver Lesions

After hemangioma, focal nodular hyperplasia (FNH) is the second most common benign liver tumor. Although it occurs also in males, it is much more common in women, in whom it commonly presents in the third or fourth decade of life. In 85% of the cases, the lesion is less than 5 cm in size at detection. It is usually asymptomatic, and therefore most lesions are detected incidentally on cross-sectional imaging, including abdominal CT. However, with increasing size, it may cause pain, discomfort, or a palpable mass. Rarely, several FNH lesions may coexist. The appearance on CT is that of a slightly lobulated soft tissue mass, which is iso- or hypoattenuating as compared to the surrounding parenchyma on non-enhanced CT. In the arterial post-contrast phase, the lesion is typically homogeneously hyperattenuating as compared to the liver parenchyma, with a central "scar" of less enhancement. In the portal phase and later, the FNH is more or less isoattenuating with the parenchyma (Fig. 13), while the central scar often shows gradual enhancement on later phases (Hussain et al. 2004). In rare cases, the central scar remains hypoattenuating after intravenous contrast administration, making distinction from fibrolamellar hepatocellular carcinoma with central necrosis difficult. In some cases (16–40%), the central scar is small or not clearly recognizable on CT, making the diagnosis less specific (Mortele et al. 2000). In such cases, MRI may be helpful to establish the diagnosis (Hussain et al. 2004).

Hepatic adenomas are less common than cysts, hemangiomas, and FNH. As with FNH, they are more common in women of childbearing age, but a stronger association with oral contraception medication has been shown for adenomas, in addition to a strong association with steroid (mis-)use. There is also a long-term increased risk of malignancy, not seen with FNH. A hepatic adenoma may cause symptoms, such as pain, discomfort, or other symptoms related to a mass effect, but symptoms may also be more acute, related to rupture and bleeding. With increased use of abdominal CT, an increasing proportion of hepatic adenomas are identified as incidental findings on CT. Their detection and differentiation from FNH (and hepatocellular carcinoma) are important, as hepatic adenomas may be candidates for more intense follow-up or surgical removal, which is not usually the case for FNH.

Apart from occasional bleeding, some adenomas develop necrosis, recognizable on imaging examinations. In 5–10% of cases, calcifications may be seen on CT. Hepatic adenomas usually occur as single lesions, mostly in the right lobe of the liver but may be multiple. They are usually well circumscribed, non-lobulated, and iso-attenuating with the liver parenchyma before contrast enhancement. Due to varying elements of intra-tumoral fat and post-hemorrhage tissue reactions, they may appear irregularly hypo- or hyperdense. In case of liver steatosis, they may occur as hyperdense in comparison with the liver. After intravenous contrast administration, small adenomas tend to be hyperattenuating on imaging in the arterial phase and isoattenuating in the portal phase (Grazioli et al. 2001). Unlike FNH, there is no central scar in adenomas, unless mimicked by central necrosis. Overlapping CT imaging features between hepatocellular carcinoma, FNH, and adenoma makes characterization at incidental detection on CT difficult. In the clinical situation, this is not trivial, and, therefore, a combination of multiphase CT and MRI is often necessary to obtain a final diagnosis (Grazioli et al. 2005).

8.4 Approach to an Incidental Liver Mass Detected on CT

Many liver lesions detected incidentally on abdominal CT are small and of uncertain clinical importance. An isolated 8 mm liver lesion of unclear etiology in an 85-year-old patient without known malignancy is probably of very minor clinical importance, while a similar finding in a 30-year-old male body builder using anabolic steroids may be of potential clinical importance, requiring follow-up. Both lesion size and patient background factors, as well as comorbidity and life expectancy, clearly have to be taken into consideration when evaluating incidentally detected liver lesions. The American College of Radiologists (ACR) Incidental Findings Committee has published guidelines regarding the management of incidental liver masses (Berland et al. 2010). They suggest that patients with incidental liver lesions be categorized according to risk status, into those with low, average, or high risk: *Low risk individuals* are defined as "young patients (≤40 years old), with no known malignancy, hepatic dysfunction, hepatic malignant risk factors or symptoms attributable to the liver." *Average risk individuals* are defined as those ">40 years old, with no known malignancy, hepatic dysfunction, abnormal liver function tests or hepatic malignant risk factors or symptoms attributable to the liver". *High risk individuals* are defined as those "with known primary malignancy with a propensity to metastasize to the liver, cirrhosis, and/or other hepatic risk factors. Hepatic risk factors include hepatitis, chronic active hepatitis, sclerosing cholangitis, primary biliary cirrhosis, hemochromatosis, hemosiderosis, oral contraceptive use, anabolic steroid use" (Berland et al. 2010).

Although multidetector CT with thin slices may sometimes reveal focal liver lesions measuring only 2–3 mm in size, characterization of lesions measuring 0.5 cm or even 1 cm in size may be difficult and uncertain. The ACR suggests that incidental liver *lesions < 0.5 cm* in low- or average-risk patients (as defined above) should be considered as benign, requiring no follow-up. In high-risk patients, follow-up in 6 months by CT or MRI is recommended, for example, in case of cirrhosis. *Lesions measuring 0.5–1.5 cm* with benign features, i.e. typical hemangioma or homogeneous, sharply marginated, low-attenuation lesions (up to about 20 HU), with no contrast enhancement, should be considered as benign, requiring no follow-up in any of the risk groups. Apart from hemangiomas, cysts and hamartomas are included in this group. *Lesions 0.5–1.5 cm* with low attenuation but suspicious imaging features, such as ill-defined margins, enhancement >20 HU, or heterogenous appearance, should have follow-up (6 months or closer) in all risk groups. *Lesions 0.5–1.5 cm* with "flash filling" ("robustly enhancing"), such as typical hemangioma or FNH in patients with low or average risk, need no further follow-up. If "flash filling" or robustly enhancing lesion occurs in high-risk patient, evaluation with MRI or follow-up in 6 months should be considered. For high-risk patients, comprehensive guidelines for the identification of hepatocellular carcinoma have been published by EASL-EORTC (2012). For *lesions > 1.5 cm* with low attenuation and benign appearance, no further follow-up is needed. *For lesions > 1.5 cm* with low attenuation but suspicious imaging features (as above), low-risk patients should have follow-up in 6 months, average-risk patients should have prompt evaluation, preferably with MRI, and for high-risk patients, biopsy should be considered. For *lesions > 1.5 cm* with "flash filling" (robustly enhancing) and benign imaging features, hemangioma, FNH, or other benign etiologies should be confirmed, if not confidently diagnosed with CT. If the CT shows robust enhancement but no benign diagnostic features, multiphasic MRI and possibly biopsy should be performed to confirm or rule out hepatocellular carcinoma and metastatic liver disease.

A structured approach to incidentally detected liver lesion on CT examinations as described above (Berland et al. 2010) is certainly valuable and helpful but not always possible to follow. Shortage of staff or machines, long waiting lists, cost containment, and priorities versus other patient groups come into play in daily clinical work and in scheduling patients for evaluation and follow-up. In the era of patient-centered care, also the preferences of the patient need to be taken into account. Structured guidelines should therefore be seen as guidelines for obtaining reasonably safe and adequate patient care.

8.5 Steatosis

Steatosis of the liver parenchyma is a very common finding on abdominal CT, if actively looked for. Using a threshold of 40 HU, Boyce et al. (2010) found steatosis in 6.2% of 3,357 asymptomatic individuals undergoing screening CT colonography at a mean age of 57 years (Boyce et al. 2010). Steatosis may vary in degree over time, as measured on abdominal CT (Hahn et al. 2015). When marked, steatosis may be apparent for to the naked eye when the hepatic vasculature

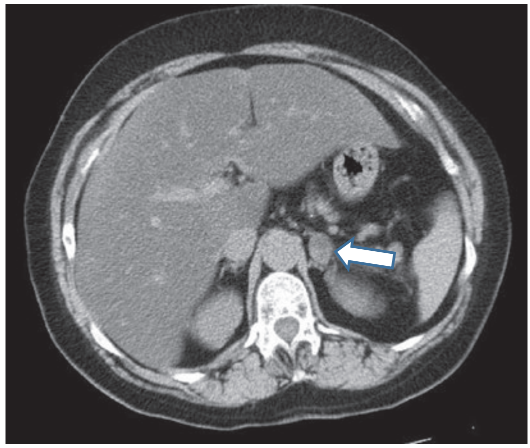

Fig. 14 A 69-year-old female with acute abdominal pain. Non-enhanced CT of the abdomen was performed, showing no bowel obstruction or other acute disorders. Incidentally, a 2.3 cm left adrenal lesion was found (*arrow*), with low but slightly irregular density (5–18 Hounsfield units). Seventeen months follow-up showed no change and no hormonal overproduction. As a second incidental finding, marked liver steatosis was noted (density values <10 Hounsfield units). Note that the normal non-contrast-enhanced hepatic vessels appear hyperdense in comparison with the low-density liver parenchyma

has a higher density than the surrounding liver parenchyma on non-enhanced CT (Fig. 14). Considering the potential relationship between liver steatosis and the metabolic syndrome and other metabolic and hormonal disorders, it seems reasonable to regularly scrutinize the liver for steatosis on abdominal CT and to report it to the referring physician, although there is no immediate therapeutic action or patient benefit coupled to such a finding, at present.

9 Gallbladder and Biliary Tree

Asymptomatic gallstones are one of the most common incidental findings on abdominal CT. In the study of Sconfienza et al. (2015) of about 1,000 abdominal CT examinations, gallstones were the most frequent incidental finding. In most cases, this is a trivial finding, but it should be mentioned in the radiology report for clinical correlation. CT is very sensitive to calcium deposits, meaning that most calcified gallstones are identified, but many gallstones are only faintly or not at all calcified and are easily missed on CT, while they are apparent on ultrasonography. When gallstones are encountered, the gallbladder wall should be scrutinized to reveal inflammatory or chronic general wall thickening. Similarly, widening of the extra- and intrahepatic biliary tree should be search for. A common bile duct >7 mm in a patient with the gallbladder present and >10 mm after cholecystectomy can be considered as dilated and indicative of obstruction (Sebastian et al. 2013).

Gallbladder wall calcification (porcelain gallbladder) has been claimed to be associated with gallbladder cancer, but the association appears weak, and the ACR Incidental Findings Committee does not generally recommend follow-up for calcified gallbladder wall without an associated soft tissue mass (Sebastian et al. 2013).

Uniform gallbladder wall thickening over 3 mm without a mass lesion can be associated with previous inflammation (chronic cholecystitis) but, importantly, also with, e.g., congestive heart failure and hypoproteinemia.

Although seen more commonly on ultrasonography, gallbladder polyps and cancer may occasionally be detected incidentally on CT (Mellnick et al. 2015). Soft tissue filling defects with contrast enhancement are suggestive of polyps. If <10 mm in size, these are likely benign, but follow-up with ultrasonography for growth is recommended if 5–10 mm, while removal should be considered if >10 mm (Sebastian et al. 2013). Irregular focal gallbladder wall thickening with contrast enhancement can be indicative of gallbladder cancer, which is the most common biliary tract cancer. It is frequently incidental, but only in the meaning that it is unsuspected until detected at laparoscopic or open gallstone surgery in a symptomatic patient (Cavallaro et al. 2014).

10 Spleen

Most incidental findings of the spleen are benign and of no clinical consequence. Malignant splenic abnormalities are often accompanied by other findings indicative of malignancy. There is considerable overlap in the CT appearance of benign and malignant abnormalities. A comprehensive overview of incidental splenic lesions and their management have been presented by the ACR Incidental Findings Committee (Heller et al. 2013).

11 Lymph Nodes

Incidental detection of single, clustered, or generalized lymph node enlargement is an important finding, which may indicate lymphoma or other malignancies. If not generalized, however, it is difficult to determine the clinical importance of the finding, considering the normal variation in size and the overlap in appearance of inflammatory, reactive, and malignant nodes. Lymph nodes in the abdomen and pelvis tend to have different sizes in different compartments, and there is a variation normally in the number of visible nodes on CT. Short-axis node diameter provides stronger correlation to malignancy than long axis and is recommended for assessment. Short axis of 1 cm or more can be considered as abnormal in the retroperitoneum (Heller et al. 2013), although nodes in, e.g. the retrocrural space, normally are smaller. In patients with malignancy, enlarged nodes on CT are likely to be malignant but may also be reactive and benign. Conversely, normal node size does not exclude malignant involvement. An increased number of normal-sized nodes may be indicative of a pathological process. It has been suggested that a cluster of three or more nodes in a single node station or a cluster of two or more nodes in two nodal stations is suspicious. If encountered in the absence of clinical explanation, a 3-month follow-up for growth may then be motivated (Heller et al. 2013).

Isolated enlargement of mesenteric lymph nodes is sometimes detected incidentally, combined with an infiltrated, encapsulated fatty mesenteric tissue and a perivascular fatty rim. These findings are indicative of sclerosing mesenteritis (panniculitis) (Sabate et al. 1999), which may be asymptomatic or present with vague abdominal symptoms.

12 Pancreas

12.1 Solid Tumors

Solid tumors of the pancreas usually represent ductal adenocarcinoma or neuroendocrine neoplasms. Incidental detection of solid pancreatic adenocarcinoma is uncommon and probably contributes only marginally to the overall survival for this patient group at large. Neuroendocrine tumors may be functional, i.e. hormone producing, named after the hormones produced, e.g. insulinomas and gastrinomas. Incidentally detected neuroendocrine neoplasms are likely to be nonfunctional and symptom-free. In a retrospective review of cases referred for assessment of solid pancreatic masses, 24 (7%) of 321 cases were detected incidentally (Goodman et al. 2012). Of these, 14 were adenocarcinomas and ten were neuroendocrine tumors, initially identified on CT performed for various unrelated reasons and with varying examination protocols. Only two of the tumors were located in the head of the pancreas, the rest being located in the body, tail, or uncinate process. Of the 14 adenocarcinomas, eight were hypodense and six were isodense with the pancreatic parenchyma, while seven of the ten neuroendocrine tumors were hyperdense. In total, 16 of the 24 tumors exhibited an obvious mass. The remaining eight cases were identified by indirect signs, such as subtle deformity of the pancreatic contour, a dilated main pancreatic duct (>3 mm) (interrupted duct sign) due to obstruction by the tumor (Goodman et al. 2012), or an effacement of the normal intrapancreatic fat. It seems likely that such subtle signs may be overlooked in many clinical circumstances. Eleven of the 24 patients had metastases already at the time of incidental detection, and the overall survival in those with adenocarcinoma was only 22 months, reflecting the dismal prognosis in pancreatic adenocarcinoma, despite presymptomatic detection. Incidental detection of a hyperdense contrast-enhancing pancreatic mass suggests neuroendocrine etiology (Fig. 15) with a slightly better prognosis (mean survival 42 months, range 16–82 months).

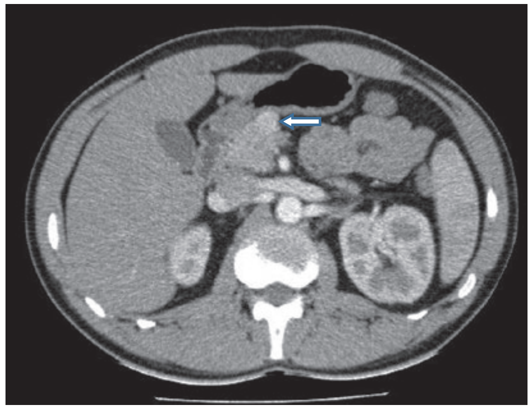

Fig. 15 A 44-year-old male with incidentally detected 1.7 cm hyperattenuating solid lesion in the anterior part of the pancreas (*arrow*), visualized on arterial phase CT. After further characterization with MRI and somatostatin-receptor scintigraphy, the lesion was surgically removed. Histological analysis showed benign neuroendocrine tumor

12.2 Cystic Lesions

As compared to solid pancreatic tumors, cystic pancreatic lesions are more common as incidental findings on CT and much more likely to be benign. Over the last decades, there has been a marked increase of incidentally detected cystic pancreatic lesions, due to the increased use and improved resolution and overall image quality of multidetector CT and due to increased awareness of their existence. In an analysis of consecutive cystic pancreatic lesions subjected to surgery over a 33-year time period, there was an increase of incidental detection from 22% in 1978–1989 to 50% in 2005–2011 (Valsangkar et al. 2012). Laffan et al. (2008) retrospectively reexamined 2,832 contrast-enhanced abdominal outpatient CT examinations, excluding those with symptoms or history of pancreatic disorders. In that population with a mean age of 58 years, they found cystic pancreatic lesions in 73 cases (2.6%). No pancreatic cysts were found in those under 40 years of age, while the frequency in the age group 80–89 years was 8.7%. The incidental detection rate in ordinary clinical situations may be lower as the purpose of the study (Laffan et al. 2008) was to specifically look for pancreatic lesions, not considering other perhaps more clinically urgent conditions, which in a clinical situation may have drawn attention away from the pancreas. It should also be noted that only contrast- enhanced CT examinations were evaluated. In non-contrast-enhanced CT examinations, the incidental detection rate may be lower, due to less conspicuity of the lesions in the absence of intravenous contrast injection. On the other hand, the real frequency of cystic pancreatic lesions may be considerably higher than that found on CT, as MRI has shown a frequency of 13.5% (Lee et al 2010), and autopsy studies revealed cystic pancreatic lesions in up to 24% of the studied population (Kimura et al. 1995).

In a recent, large, retrospective analysis of predominantly men (88%), including all cyst etiologies, patients with pancreatic cysts had nineteen times higher risk of developing pancreatic cancer over 8 years observation, compared to those without a diagnosis of pancreatic cysts (Munigala et al. 2016).

When the radiologist encounters an incidental cystic pancreatic lesion, the first question to be asked is if it could represent a pseudocyst associated with previous acute pancreatitis or chronic pancreatitis. This may be apparent from available earlier radiological examinations or from medical files and may also be indicated by CT findings such as parenchymal calcifications, necrotic areas, dilatation of the main duct and side branches, parenchymal atrophy, and extrapancreatic location of the pseudocyst. In other cases, the differentiation between a pseudocyst and a mucinous cystic neoplasm may be difficult and of concern, as the clinical handling and prognosis are different.

If a pseudocyst and cyst-like necrosis in a solid pancreatic cancer can be ruled out, the cyst is likely to represent a serous cystadenoma (SCA), mucinous cystic neoplasm (MCN), or intraductal papillary mucinous neoplasm (IPMN) (Fig. 16). Comprehensive guidelines on the management of MCN and IPMN have recently been published (Tanaka et al. 2012). Serous cystadenomas are benign tumors with female preponderance, occurring in elderly women (median age 68 years), therefore sometimes called "grandmother tumor" (Zaheer et al. 2013). On CT, they may occur as a mass consisting of small, multiple cysts with multiple septations and sometimes a characteristic central scar with or without calcification.

Fig. 16 Incidentally detected 1.5 cm cystic mass in the body of pancreas (*arrow*) on contrast-enhanced CT in a 75-year-old male. Further characterization with MRI was suggestive of side-branch intraductal papillary mucinous neoplasm (IPMN). Surgical removal confirmed IPMN with high-grade dysplasia

Further investigation of incidentally detected cystic pancreatic lesions includes a multiphase CT, including native, arterial, as well as venous phase imaging. MRI has a similar, or better, accuracy in differentiating benign from malignant cystic pancreatic lesions, and together with MRCP allows visualization of the pancreatic duct, and in case of branch duct IPMN, the connection to the main pancreatic duct (Tanaka et al. 2012). Although not performed as first-line investigation, PET-CT has the highest accuracy in this respect (Kauhanen et al. 2015). If uncertainty remains, endoscopic ultrasonography with fine needle aspiration is a recommended option (Muthusamy et al. 2016).

13 Gastrointestinal Tract

Incidental findings of the gastrointestinal tract on abdominal CT occur occasionally but constitute a difficult area depending on the wide normal variation of the bowel wall appearance. In a series of 2,014 individuals undergoing CT colonography screening, an unsuspected tumorous lesion of the extracolonic gastrointestinal tract was found in ten asymptomatic individuals (0.5%) (Pickhardt et al. 2007). The lesions measured 1.0–3.4 cm.

Three of them were located in the stomach (one lipoma, one polyp, one leiomyoma), two in the jejunum (one lipoma, one hamartoma), three in the ileum (one lipoma, one hamartoma, one leiomyoma), and two in the appendix (two mucinous adenomas).

13.1 Stomach

Mass lesions in the stomach are notoriously difficult to detect and characterize, as a non-distended stomach has a thick wall, difficult to differentiate from true wall thickening. Likewise, a normal thick-folded stomach wall is easily misinterpreted as tumorous or infiltrated. This means that radiologists should be very careful in evaluating the stomach wall thickness, unless the stomach is well distended, or a clear abnormality is indicated by, e.g. focal thickening and distinctly abnormal contrast enhancement.

13.2 Small Bowel

Obstruction, perforation, and acute inflammatory intestinal disorders rarely present as incidental findings. Chronic inflammatory or postinflammatory bowel wall thickening may occur as an incidental finding in asymptomatic patients examined for unrelated reasons, while tumors of the small bowel are rare, both as symptomatic and incidental findings (see above). Asymptomatic duodenal or other diverticula may be occasional findings. Incidental Meckel's diverticula are frequently missed on CT of asymptomatic patient, but their identification is facilitated if bowel loops are separated by abundant intraperitoneal fat (Kawamoto et al. 2015).

13.3 Large Bowel

Colon cancer is the second or third most common cancer in both men and women in the western world. It is well known that early diagnosis is beneficial and associated with better outcome, as shown in screening studies using fecal occult blood tests followed by colonoscopy and removal of precancerous polyps (Hardcastle et al. 1986; Mandel et al. 1993; Kronborg et al. 1996). Opportunistic screening by scrutinizing the colon in abdominal CT examinations performed for unrelated reasons, in order to find such cancer tumors or precancerous polyps, may therefore seem like a good idea. Although colon cancer and large adenomas sometimes are incidentally identified on standard abdominal CT, small- and medium-sized colonic polyps cannot be expected to be identified without preceding bowel cleansing and rectal gas distension of the bowel. Localized, tumor-like colon wall thickening or "stricture" is frequently reported by radiologists as an incidental, tumor-suspected finding on abdominal CT. Such findings may represent asymptomatic colon cancer or adenoma and may, when detected and reported, contribute to early treatment by endoscopic or surgical removal and thereby better prognosis. Not seldom, however, the endoscopist finds no lesion, suggesting that the incidental CT finding was false positive. This reflects the difficulty in differentiating the normal colonic wall "thickening" that occurs with bowel wall relaxation, from wall thickening caused by a colonic mass lesion, in a non-distended colon. Radiologists should be aware of this normal variability in appearance of the colon walls, frequently depicted on CT colonography, where a poorly distended segment in one body position may show tumor-like symmetrical or asymmetrical wall thickening, while it appears completely normal when well distended in the other body position (Fig. 17). In order to avoid misinterpretation, one has to critically assess the degree of bowel distension and the symmetry and extent of wall thickening. Bowel content may also lead to false-positive findings. Unlike most polyps, fecal material frequently shows angular shape and often contains gas components, and density measurements show lower HU values than organic tissue.

Despite the risk of false-positive findings and overdiagnosis of colonic tumors, the colon should be scrutinized in every abdominal CT in middle-aged and elderly patients, considering the potential benefits of detecting an early cancer or precancerous adenoma.

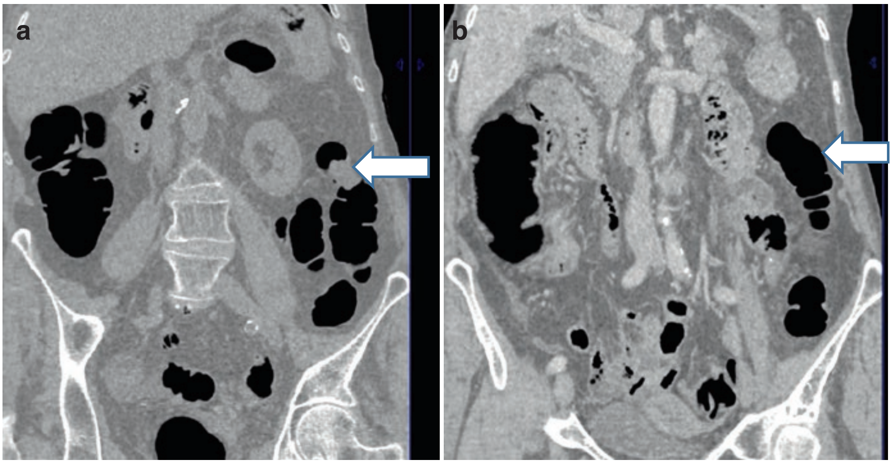

Fig. 17 (**a**, **b**) Patient admitted because of large bowel symptoms. CT colonography shows focal mass-like structure in the descending colon in prone position (**a**, *arrow*), while the same colon segment appears normal on images obtained shortly thereafter in the supine position (**b**, *arrow*). The finding represents a focal contraction of the colon, sometimes seen on abdominal CT, and represents a potential source of false-positive colonic finding on abdominal CT

13.4 Appendix

Occasionally, a mucocele of the appendix may be incidentally detected on abdominal CT, as approximately 25% of these are asymptomatic. Mucoceles occur primarily in patients over 50 years of age, with some female preponderance. Mucocele is an important incidental finding for two reasons. First, with growth it may rupture, causing dissemination of mucinous material in the abdominal cavity, resulting in pseudomyxoma peritonei. Second, a mucocele may be malignant, and the patient can benefit from early surgical removal. A mucocele is a fluid-filled tubular pelvic lesion anatomically in contact with the cecum (Fig. 18). It may simulate other pelvic cystic masses (Moyle et al. 2010). The absence of a normal-appearing appendix may be a clue to the diagnosis on CT. Depending on the degree of lumen obstruction, the mucocele gradually distends, so it can be of variable size at detection. There may be irregular wall thickening and occasionally calcifications. Mucoceles are usually benign, originating from either a nonneoplastic occlusion of the appendiceal lumen or from an obstruction due to mucinous cystadenoma or adenocarcinoma of the appendix. Thus, a mucocele may be malignant. Importantly, if a mucocele is suspected, no biopsy or percutaneous drainage should be attempted, as this may cause spillage of the content into the peritoneal cavity.

14 Vascular Structures

The most important incidental vascular finding on abdominal CT is abdominal aortic aneurysm (AAA). It is defined as an abdominal aortic diameter of 3 cm or more or an increase of 1.5 times the normal diameter. The ACR Committee on Incidental Findings recommend follow-up every 5 years for patients with ectatic aortas measuring 2.5–2.9 cm, every 3 years for aortas measuring 3.0–3.4 cm, every 2 years for 3.5–3.9 cm, every year for 4.0–4.4 cm, every 6 months for 4.5–4.9 cm, and every 3–6 months for larger aneurysms (Khosa et al. 2013). AAA is more frequent in men than in women, and there is an increased incidence with age. Due to the risk of rupture, many countries have introduced ultrasound screening for AAA in men, in order to identify those in need of follow-up or preventive surgery. However, measurements of aortic diameters on non-enhanced or enhanced CT are also easily obtained (Fig. 19) and provide an opportunity for collateral or opportunistic AAA screening,

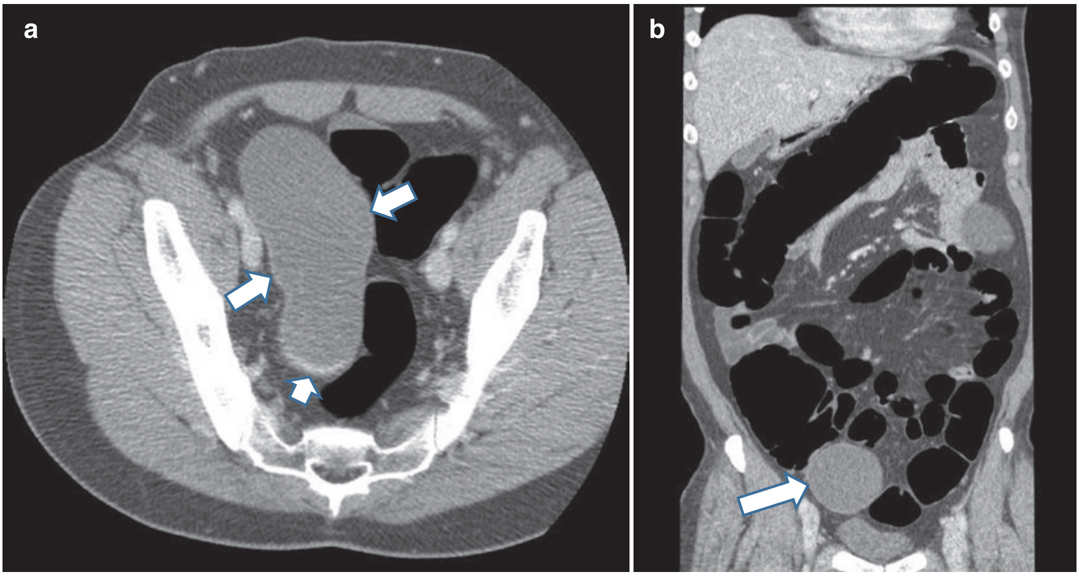

Fig. 18 A 55-year-old symptom-free male screened with CT colonography, which revealed no intra-colonic tumor but a large extracolonic tubular, low-density (20–30 HU) lesion (**a**, **b**, *long arrows*), in anatomical connection with the cecum. Thin calcifications were noted in part of the wall of the lesion (a, *short arrow*). No normal-appearing appendix could be identified. Appendiceal mucocele was suggested and confirmed at surgery. The lesion ruptured when surgically removed. Histological analysis confirmed a benign appendiceal mucocele

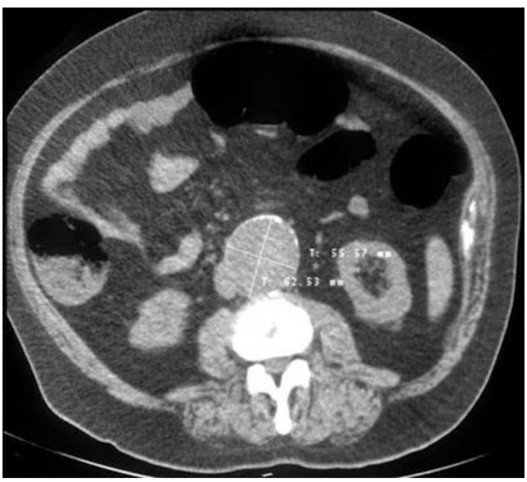

Fig. 19 A 6.2 cm abdominal aortic aneurysm incidentally detected on CT colonography. With this size of aneurysm, the patient is a candidate for elective endovascular aortic repair (EVAR)

which may be beneficial considering the long-term risk of aneurysm rupture and death. Iliac artery aneurysms are also common incidental findings, defined as a diameter of 2.5 cm or more (Khosa et al. 2013). Iliac artery aneurysms, like aneurysms in the splenic and renal arteries, are usually part of generalized atherosclerosis and sometimes coexist.

Incidental detection of calcifications in the aorta and abdominal arteries can be considered normal features of aging. However, if occurring in young patients, especially if there is suspicion of bowel ischemia (mesenteric arteries) or drug-resistant hypertension (renal artery stenosis), it may be beneficial information that should be conveyed to the referring physician.

15 Adnexal and Uterine Lesions (Not Including Incidental Lesions in Children or Pregnant Women)

In some settings, gynecological imaging is mostly handled by gynecologists, with transvaginal ultrasonography as their main imaging tool. This tends to make radiologists less involved in the imaging and workup of the gynecological organs. When there is a need for complementary imaging, MRI is usually the first choice, although CT has an important role in the workup of symptomatic patients with, for example, pain or infection and in preoperative assessment. Nevertheless, incidental findings in the female reproductive organs on CT of the abdomen and pelvis are common and need to be tackled by the radiologist. In fact, incidental gynecological findings were made in 9.5% of 749 women undergoing CT colonography, and 20% of these underwent further radiological or surgical workup – all with a benign outcome (Stitt et al. 2009). This suggests that radiological reports to some extent may convey "false alarms." In a recent study of contrast-enhanced abdominal CT (mean age 67 years), gynecological findings comprised 7% of the clinically significant (C-RADS E4 findings) incidental findings (Sconfienza et al. 2015). The impact of incidental gynecological findings on abdominal CT is also indicated by the fact that women accounted for 79% of follow-up costs for extracolonic findings in a CT colonography study, mostly attributed to suspected gynecological findings (Xiong et al. 2006).

Clearly, incidental gynecological findings on abdominal CT should not be ignored but must be handled sensibly by the radiologist, as most of the findings are benign. In a retrospective study of postmenopausal women undergoing hysterectomy for various reasons, the prevalence and histology of coexisting adnexal mass lesions were investigated (Annaiah et al. 2012). They found ovarian pathology in 31% of 200 adnexa. Over half of these were unilocular cysts, 15% were multilocular cysts, 18% were solid tumors, and 11% were uni- or multilocular cysts with solid nodules. Malignant lesions were found in 5% and borderline tumors in 4%. However, all tumors below 2 cm in size were benign, and all unilocular cysts below 5 cm were benign. Further support for a benign course of unilocular ovarian cysts was provided in a large screening study of 15,000 women aged 50 years or more, followed periodically with transvaginal ultrasound (Modesitt et al. 2003). Unilocular ovarian cysts were found in 18% of the population. The mean size of the lesions at the time of detection was 2.7 cm, and 69% had a diameter below 3 cm. Sixty-nine percent of the cysts resolved spontaneously during a mean of 6.5 years follow-up, most of them within 3 months. Over time, 16.5% of the cystic lesions developed septations and 5.8% developed a solid area, but none of the women with an isolated unilocular ovarian cyst developed malignancy during the study period. The authors concluded that a clearly unilocular ovarian cyst at ultrasonography carries an extremely low risk to develop cancer (Modesitt et al. 2003). Although findings at ultrasonography are not always identical to those at CT, it has been recommended (Patel et al. 2013) that similar guidelines should be applied for CT as for ultrasonography, with only slight modifications (Levine et al. 2010).

Factors which add to the complexity in interpretation of adnexal lesions is the normal variation in appearance of the reproductive organs in the different menstrual phases and their different appearances in pre-and postmenstrual women, as well as potential effects of, e.g., contraceptive medication and hormone replacement therapy. A particular problem in clinical practice is that the date of the last menstrual period is often unknown for the individual radiologist. After menopause, the postmenopausal period is divided into an early phase (within 5 years after menopause) and a late phase (later than 5 years after menopause). In a White Paper from The American College of Radiology (ACR), it is suggested that when the menstrual status is not known, women up to 50 years of age could be considered premenopausal and those over 50 years postmenopausal (Patel et al. 2013), although in reality, there is a considerable overlap.

15.1 Adnexal cysts and teratomas

The most common adnexal lesion likely to present as an incidental finding on CT is a cyst or cyst-like lesion. In a woman of premenopausal age, an incidentally detected cystic adnexal lesion often represents a dominant physiologic ovarian follicle, which normally develops during the follicular phase of the menstrual period. These follicles are sometimes counted as cysts, and they fulfill the criteria for simple, benign adnexal cysts, i.e. unilocular cysts of round or oval shape, with uniform fluid attenuation and regular or imperceptible wall and without solid areas or mural nodules (Patel et al. 2013). In other cases, the cystic lesion may represent a corpus luteum cyst, which is seen normally during the second half of the menstrual cycle (and during the first trimester of pregnancy). The typical CT appearance of a corpus luteum cyst is that of a 1–3 cm cystic lesion with homogeneous non-enhancing cyst content and a thick wall, which is clearly enhancing after intravenous contrast administration, sometimes called the "hyperenhancing rim sign" (Bonde et al. 2016). On Doppler ultrasonography, this vascularized wall has been termed a "wall of fire," due to its rich blood supply. This enhancing wall is, however, not unique for a corpus luteum cyst, as similar findings may be made in, e.g., ectopic pregnancy (Lin et al. 2008) and in abscesses which, however, are unlikely to occur as incidental findings. Occasionally, the corpus luteum cyst may bleed, causing fluid layering and rupture. Bleeding into the cyst may make the cyst content irregular with increased internal density, making it more difficult to differentiate on CT from other lesions, such as endometrioma or ovarian neoplasms (Bonde et al. 2016). In contrast, endometrioma can be clearly differentiated using MRI. Adnexal cystic lesions may also be located outside the ovary, para-ovarian cysts, and sometimes peritoneal cysts or tortuous tubular structures, such as a dilated fallopian tube (sactosalpinx) may mimic an adnexal cyst on CT. The ACR (Patel et al. 2013) suggests that incidentally detected benign-appearing adnexal cysts 5 cm or smaller in premenopausal women need no follow-up, while those larger than 5 cm should have follow-up with ultrasonography at 6–12 weeks. In postmenopausal women, a similar benign-appearing cyst needs no follow-up if 3 cm or smaller, while larger cysts should have prompt follow-up with ultrasonography (Patel et al. 2013). However, based on results from combined autopsy and ultrasound studies, benign cysts are very frequent and merely a normal finding in postmenopausal women (Valentin et al. 2003), and it is therefore suggested that unilocular, benign-appearing cysts <5 cm need no follow-up in postmenopausal women, due to the small risk of malignancy (Timmerman et al. 2005).

The ACR Incidental Findings Committee on Adnexal Findings also defines a category with "probably benign cyst," i.e. cysts that fulfill the CT criteria for a benign cyst, except for one of the following observations: angulated margins, not round or oval in shape, or if the cyst is poorly imaged. In premenopausal women, such cysts should have ultrasound follow-up if 3 cm or larger, and if 5 cm or larger, prompt ultrasound examination. In postmenopausal women, such a finding should initiate prompt ultrasound examination if the cyst is 3 cm or more. For women in the late postmenopausal phase, the ACR guidelines suggest that even 1 cm cysts with such characteristics should be subjected to prompt ultrasonography, but patient age, comorbidity, and patient preferences have to be taken into account in the decision-making.

Incidental cystic adnexal lesions which do not fulfill the criteria for benign or probably benign cysts on CT (except dermoid cysts, see below) should be promptly referred to ultrasonography for further characterization, treatment, or follow-up. These are lesions with a large size (see above) and/or other characteristics that disqualify them as benign cysts on CT examination, such as solid components, papillary vegetations, necrosis, thick septations, or wall thickening (Fig. 20). It should be noted, however, that thick septations and wall thickening also are features of tubo-ovarian abscesses, endometriomas, and some benign tumors and therefore not specific for malignancy. Nevertheless, any non-cystic solid incidental adnexal lesion should be sent for prompt ultrasound examination or MRI if indicated. The ovary itself may appear on contrast-enhanced CT as hypodense as related to the surrounding tissues and the myometrium. This should not be mistaken for a cystic mass.

Among other incidental findings on CT, dermoid cysts or teratomas should be mentioned. These are mixed tumors, with elements from ectoderm, mesoderm, and endoderm, in varying proportions. Mature cystic teratomas (dermoid cysts) may occur in young women, can be

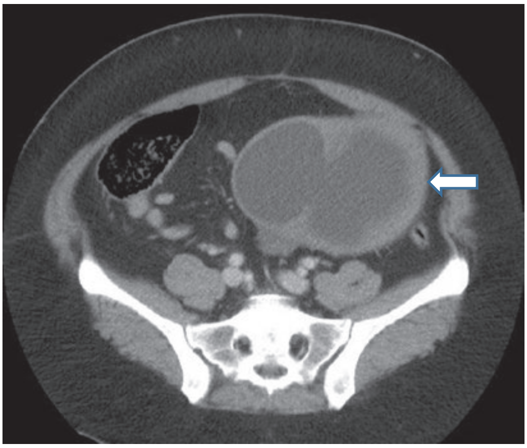

Fig. 20 Cystic mass incidentally detected in a woman examined with abdominal CT for an unrelated reason. The lesion was septated and thick walled (*arrow*). Mucinous cystadenoma was histologically confirmed

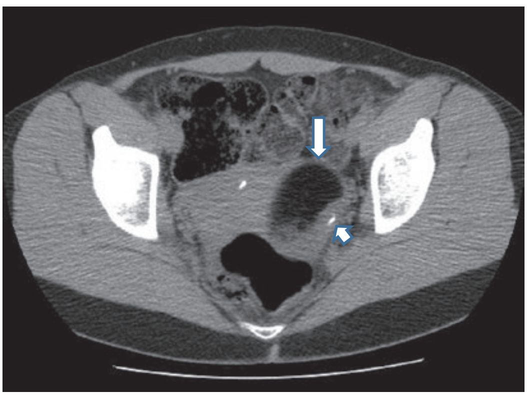

Fig. 21 Dermoid cyst with components of fat (*long arrow*), soft tissue, and bone or teeth (*short arrow*) incidentally detected on abdominal CT in a 44-year-old woman. The patient was operated and histology confirmed a benign dermoid cyst (teratoma)

bilateral (10%), and are slow growing. They are filled with liquid sebaceous material and contain elements from e.g. hair, skin, teeth, bone, and fat, which are present in most cases and tend to protrude locally from the wall (Rokitansky nodule), projecting into the cyst. The key to CT diagnosis is the occurrence of fatty content and elements of bone or teeth in a mixed pelvic mass, easily recognized on CT (Outwater et al. 2001) (Fig. 21). In a pelvis with a lot of fatty tissue, the fatty component of a teratoma may be difficult to distinguish at first glance, but the characteristic calcifications located outside the uterus and vascular tree should raise the suspicion of a dermoid. Cystic teratomas are usually benign tumors, but about 1% are, or develop into, malignant variants. In particular, immature ovarian teratomas, which are more common in younger women, may have a malignant course, showing more solid tissue components and less fatty elements. Benign ovarian dermoids are usually symptom-free but may sometimes be the cause of painful rupture or torsion. Dermoids should always be reported by the radiologist, in order to allow the referring doctor and the patient to discuss and decide if the lesion should be removed.

15.2 Uterus

The most common incidental finding in the uterus is leiomyomas (fibroids), benign tumors of the uterine myometrium. Using ultrasonography, fibroids have been found in 21% of women aged 30–60 years (Marino et al. 2004), and even higher frequencies have been suggested from autopsy materials. Although it cannot be expected that CT will identify all fibroids seen on ultrasonography, they still are the most common incidental CT findings in the uterus. Typical finding on CT is a bulky or enlarged uterus with bumpy outline or a mass in continuity with the uterus. Although they may cause menorrhagia, pain, discomfort, or impaired fertility, many cause no symptoms and are detected incidentally. They are hormone dependent, develop after menarche, are most common after 30 years of age, and usually undergo reduction in size after menopause. On CT, they are commonly isoattenuating with the surrounding myometrium and usually appear slightly hypoattenuating after intravenous contrast administration. Occasionally, they may undergo degeneration and can attain a cystic appearance. In postmenopausal women, patchy, sometimes dense calcifications are commonly seen. Uterine leiomyosarcoma may have a similar appearance, and the two cannot confidently be differentiated on CT (Gaetke-Udager et al. 2016). However, uterine leiomyosarcomas are exceedingly rare as incidental findings. Incidental detection of an enlarged uterus may also indicate uterine adenomyosis, a disease with ectopic deposits of endometrial tissue within the uterine myometrium, which may cause diffuse gynecological symptoms including menorrhagia and pain. Adenomyosis may be associated with a globally enlarged uterus with thickened myometrium and focal or diffuse distribution of multiple subcentimeter myometrial cysts, sometimes detectable on CT (Woodfield et al. 2009). If suspected on CT examination, the diagnosis should be confirmed by MRI or transvaginal ultrasonography, which provides more specific findings of adenomyosis (Yitta et al. 2011).

Mass lesions of the uterine cervix are difficult to detect on CT, unless large or clearly necrotic. The uterine cervix may normally appear hypoattenuating, depending on the degree of enhancement of the myometrium, and should not be mistaken for a cervical mass. If a cervical mass is suspected, patency and secondary widening of the endocervical canal and uterine cavity should be looked for, to support the finding.

A common incidental finding in the uterine cervix is a nabothian cyst, i.e. benign, mucinous retention cysts usually 2–10 mm in size. Nabothian cysts are better depicted on MRI, and small nabothian cysts may not be discernible on CT, but otherwise they appear as low density lesions in the cervix. They may be single or multiple and are thin walled with a low-density, non-enhancing, water-like content. They are usually asymptomatic. Only rarely may they reach several centimeters in size, possibly causing symptoms. They are caused by blockage of normal glands in the cervix, sometimes related to an infectious process in the cervix. When confidently identified on CT, there is no need for further imaging or treatment, as they are benign, usually asymptomatic and may disappear (and recur) spontaneously.

Of potential clinical importance is the incidental detection on CT of a thickened endometrium, as it may indicate an endometrial neoplasm. Endometrial thickness is easily assessed with transvaginal ultrasound, while on CT it may be difficult to define the endometrium thickness, unless grossly increased, and to differentiate the endometrium from fluid in the uterine cavity. Likewise, the endometrium may have different appearance related to the imaging plane and to the anatomical variations in the shape of the uterus (ante- and retroflexion). These difficulties are reflected in a study where endometrial thickness was qualitatively assessed by two readers on CT, using transvaginal ultrasonography as reference standard. The sensitivity of CT in identifying endometrial thickening in pre- and postmenopausal women was only 53% (specificity 93.5%), and CT overcalled endometrial thickness in one third of cases (Grossman et al. 2008). The authors emphasized the value of sagittal reconstructions in addition to standard axial and coronal reformats when assessing endometrial thickness, especially when the endometrium appears triangular and thickened on axial views. Using sagittal views and measuring the hypoattenuating inner-to-inner diameter on contrast-enhanced CT, Kang et al. (2014) found a high accuracy in determining the endometrial thickness, using the established criteria for ultrasonography (16 mm for premenopausal and 5 mm for postmenopausal women). It can be concluded that the endometrium should be scrutinized on CT performed for unrelated reasons in pre- and postmenopausal women, but the limitations mentioned above must be taken into account, while cases of clearly thickened endometrium should be further evaluated by endovaginal ultrasonography, taking effects of e.g. hormonal replacement into account.

16 Prostate

The prostate gland is usually not in focus in abdominal-pelvic CT. Most radiologists probably report incidentally detected prostatic enlargement, at least if gross or causing hydronephrosis. Prostate calcifications are common and become more frequent with age, but many prostate gland calcifications go undetected or unreported and are usually considered clinically nonsignificant. Using ultrasound, 7% of over 1,000 adults aged 21–50 years had prostate calcifications (Geramoutsos et al. 2004). Two types of calcifications were identified. The more common type was characterized by multiple small calcifications and had no relationship with symptoms. Coarse, larger calcifications were associated with prostatitis, pain, or other lower urinary tract symptoms, although the vast majority of patients with such calcifications were asymptomatic.

Of greater clinical interest is the incidental detection of prostate cancer. It is usually claimed that prostate cancer cannot be reliably identified using CT, especially in view of PSA (prostate-specific antigen) testing, multiparametric MRI, and ultrasound-guided biopsy becoming more and more available. Considering that early detection and treatment of aggressive prostate cancer may improve survival and that many men with undetected prostate cancer are going through abdominal CT for various unrelated reasons, it is important to know if the prostate really can be ignored when reading CT. The role of CT for incidental detection of prostate cancer has been highlighted in two recent articles. Glazer et al. (2015) have suggested that an enhancing localized mass in the peripheral zone (especially if 1 cm or larger) is suspicious for highly relevant clinical cancer (Gleason 3 + 4 or higher grade) when detected on a venous phase contrast-enhanced CT. Other enhancing lesions had little diagnostic value. The findings are supported by another study, which compared CT findings with multiparametric MRI of the prostate (Jia et al. 2016). It must be pointed out, however, that CT has a poor overall ability to identify prostate cancer. But when focal contrast enhancement occurs in the peripheral zone, there is a high likelihood that it may correspond to a clinically significant prostate cancer. With this in mind, it seems that the prostate gland cannot any longer be ignored when routinely assessing the pelvic region on a CT examination.

17 Skeletal Lesions

Degenerative changes of the spine, such as disc height reduction and osteophytes, as well as osteoarthritis of the hips, can be detected in a large proportion of elderly persons on abdominal CT, providing that the skeleton is assessed in an

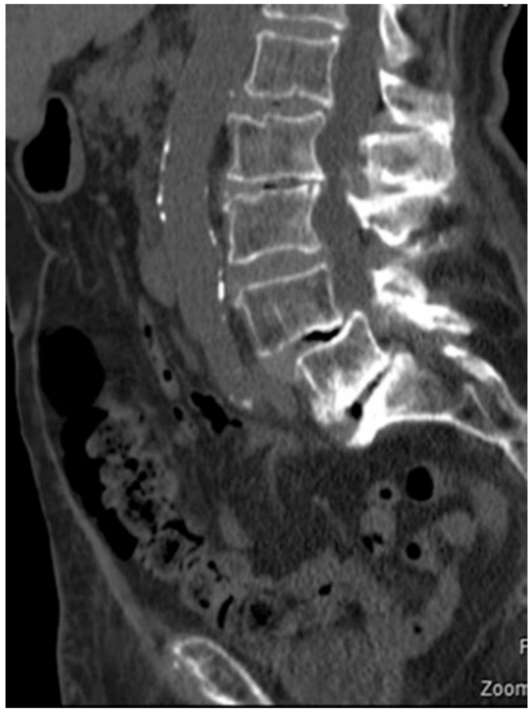

Fig. 22 Abdominal CT for acute abdominal pain, but not back pain, in an elderly woman revealed degenerative changes in the lumbar spine, including severe disc degeneration with vacuum phenomenon in several discs and spondylolisthesis with L4 slipped anteriorly on L5

appropriate image plane and with appropriate window settings (Fig. 22). As most of subtle or moderate degenerative spinal changes in the elderly can be considered as normal aging, they are not regularly reported by all radiologists. However, at least in younger patients and if the abnormalities are extensive in the elderly, the findings could be of clinical importance and should be reported.

18 To What Extent Are Incidental Findings Reported?

In clinical work, retrospective reviews of abdominal CT examinations can often reveal incidental findings that have not been mentioned in the radiology report. Published frequency figures on incidental findings can therefore be assumed to represent minimum figures of the real frequency of abnormalities. For example, in an analysis of incidental lung nodules on abdominal CT, it was shown that of 95 patients with lung nodules, only eight had this mentioned in the radiology report (Rinaldi et al. 2010). In a prospective multicenter study of adrenal incidentaloma frequency, the frequency of reported cases from the study centers was 0.9%, while a dedicated and systematic reevaluation of cases showed a frequency of 4.5% (Hammarstedt et al. 2010). Forty-seven percent of the incidentalomas found at reevaluation had not been reported to the study center and were also not mentioned in the original radiology report. This suggests that abnormalities that are not related to the main clinical question are commonly missed or ignored.

19 Why Do Radiologists Report or Not Report Incidental Findings?

Apart from real variations in frequencies of abnormal findings in different study populations, variations may be due to varying propensity to report such findings. Reasons for radiologists to report or not report incidental findings may be many. First of all, organs or tissues displayed at abdominal CT may not be fully scrutinized if they are not in clinical focus. Parts of the anatomy included in the CT scan may not be looked at, or not looked at with proper CT window settings, thereby making abnormalities less obvious. Another reason may be "satisfaction of search," i.e. feeling satisfied when having identified some relevant pathology, and not focusing enough on the rest (Berbaum et al. 1990). Even if properly displayed at the CT examination, and looked at, the incidental finding may erroneously be interpreted as normal by the radiologist (false-negative finding). Finally, the incidental finding may be correctly identified but not considered important enough to be reported, depending on the clinical question, the size, and nature of the finding and factors such as patient age and comorbidity. This is a common scenario, considering that modern CT (and MRI and ultrasound) has a high spatial and contrast resolution that allows the detection of many lesions in the size range 2–10 mm, especially in the solid organs such as the liver and kidneys. In this size range, CT density measurements (CT numbers, Hounsfield units) are unreliable, and even contrast medium enhancement is difficult to evaluate. Therefore, characterization of small lesions (<10 mm) is difficult, and this may be a reason not to report such findings. However, this does not explain non-reporting of larger lesions.

In the decision process, to report or not report, not only the size and character of the lesion but also the potential present and future clinical importance of the finding, as well as patient comorbidity and age, are crucial factors. Reporting of all detected small findings in all organs and tissues would be impractical and leads to confusion and uncertainty among referring clinicians on how to handle the findings, and it may potentially lead to unnecessary follow-up studies with associated risks of complications and increased costs, with no certain benefit. Thus, the radiologist has an important role to judge which findings should be conveyed to the clinician and which findings should be ignored, a task which is not always easy and has ethical implications. Reporting of "too many" small or insignificant findings leads to difficulties for the referring physician to decide which information is relevant and what should be conveyed to the patient. On the other hand, not detecting and reporting an incidental finding that may represent, e.g., early cancer may be catastrophic. Thus, if the lesion grows and is detected only a few years later, when it may have metastasized, and the patient (and doctor) is aware of a previous CT examination which retrospectively shows the lesion, important medicolegal and ethical questions may be raised.

20 Do the Patients Want to Know About Incidental Findings?

It is often claimed that reporting incidental findings to the patient may cause unnecessary patient worry, as it may lead to repeated follow-up studies and even interventions, often with no real benefit. It may also cause significant costs and sometimes even risk to the patient, from ionizing radiation at radiological examinations, surgery, to other interventions that may follow an incidental finding. An important question is then what the patients think about it – do patients want to know about incidental findings?

Ghanouni et al. (2012) interviewed asymptomatic middle-aged persons about their preferences in a screening situation with either CT colonography or colonoscopy, after the accuracy, side effects, and possibility to detect abnormalities outside the colon were described for both methods. Overall preference was similar for the two methods, but the ability to visualize extracolonic organs (incidental findings) was considered an advantage of CT colonography.

Plumb et al. (2014) made a discrete choice experiment of perceived benefits versus harms with CT colonography in a hypothetical colorectal screening situation. They tried to "determine the maximum rate of false-positive diagnoses that patients and health care professionals were willing to accept in exchange for detection of an extracolonic malignancy." They examined the opinions of 50 healthcare professionals and 52 patients admitted for reasons unrelated to colon symptoms. They had to make a choice between CT colonography which looks inside and outside the colon (unrestricted CT colonography), and CT colonography that looks inside, but not outside, the colon (restricted CT colonography). It was explained that the unrestricted test had a 1/600 chance of detecting a curable extracolonic cancer, but that it also had a risk of inducing unnecessary additional imaging tests or interventions, such as biopsies, endoscopies and surgery. Surprisingly, both patients and healthcare professionals stated that they would tolerate a very high rate of false-positive extracolonic diagnoses in order to find the 1/600 curable extracolonic cancer. The anticipated problem with false positive extracolonic findings at screening CTC, as seen from a patient perspective, may therefore be exaggerated. On the other hand, the study was based on a hypothetical screening scenario, which may not reflect opinions in a real life situation. Also, it did not take into account the downstream cost of such screening scenario, which may influence the overall net benefits.

Muth et al. (2013) examined the patient experience of being part of a 2-year follow-up program with repeated abdominal CT examinations, after a benign-appearing and non-hyperfunctioning adrenal lesion had been incidentally detected on a CT examination. Of the 110 patients, 85% reported some degree of worry at diagnosis but only a few remained worried during follow-up, and the overall impression was that such a follow-up program was well tolerated by the patients. It must be emphasized, though, that the patient experience of incidental findings and subsequent follow-up is heavily dependent on the amount and quality of information given from the healthcare provider. If patient information is insufficient, it can be assumed that the patient experience may be very different.

21 Who Should Decide Which Information to Convey to the Referring Physician and to the Patient?

This also raises the question who should decide what information to be conveyed to the patient. The radiologist acts as a first filter, presenting in the radiology report those findings that he or she finds relevant to report. This means that certain information, considered unimportant by the radiologist, may be left out of the report. The next filter is the referring physician, who receives the radiology report. This physician may choose to convey all or only part of the information in the radiology report to the patient, depending on personal preferences and patient situation. The third filter is the patient himself or herself. The patient may want to be informed about all findings, including reading the report, or may be satisfied with what the clinician presents as being relevant and of interest. In this chain, the radiologist is the key person, as the information that he or she conveys forms the basis for the actions of the referring physician.

Importantly, the wording of the radiology report appears to have a great impact on how an incidental finding is understood and acted upon by the referring physician and by the patient. For example, the way a radiologist describes a clearly benign cyst ("cyst," "benign cyst," "most likely a cyst" etcetera) has an impact on the degree of concern among the referring physicians and to an even larger extent among the patients, as shown in a recent questionnaire study on perceived concern over the message in the radiology report (Rosenkrantz 2017).

The radiologist must therefore not only be accurate in detecting abnormalities but also be knowledgeable about the relative importance and impact of various findings in the short- and long-time perspective. Finally, the radiologist has to put the information into proper wording in the report, not to cause unnecessary workup or patient worry, while at the same time clearly indicating if such follow-up is needed. In order do this successfully, the radiologist, in turn, needs adequate and concise clinical information on the radiology request form about the patients' medical history, other than just the indication for the current radiological examination. Knowledge about, for example, malignant or other diseases, previous surgery, and radiation therapy in patients referred for unrelated symptoms may greatly facilitate the understanding of "incidental" findings – findings that many times should not be considered incidental, but expected – providing that the clinical information was given.

22 Potential Impact of e-Medicine

A factor of potential future importance for this issue is Internet Web-based access to medical files for patients, as presently being introduced at a larger scale in several countries. This may include patients' own access to their medical records, including radiology reports, at home or anywhere by digital media. The benefits and harms of this "open access" for patients are largely unknown, but reading radiology reports and images on one's own, including descriptions of incidental findings not related to the patients main complaint, may certainly create questions and perhaps patient confusion and worry. Knowing that patients may read the reports may also have an impact on what is reported and how radiologists and physicians formulate their descriptions of findings. Further studies are needed to fully understand the benefits and problems with this development.

Conclusion

It can be concluded that detection and reporting of incidental findings on CT of the abdomen may occasionally be lifesaving, but the majority of such incidental findings are clinically irrelevant. The following advice can be given to radiologists when analyzing abdominal CT examinations:

- Make it a routine to do systematic search for incidental findings on abdominal CT, using appropriate window settings and multiple image planes.
- When identifying an incidental finding, look for prior imaging examinations. If there is, determine if there is any interval change in size or character of the lesion.
- Consider potential severity of the finding, short and long term.
- Put the finding in context of the individual patient, taking patient age, clinical history, comorbidity, and life expectancy into account.
- Moderate the radiology report according to the above.

It is the delicate task of the radiologist to balance potential benefits and risks when reporting incidental findings and recommending certain actions. On one hand, it may lead to early diagnosis and treatment, improving health and prognosis. On the other hand, this must be balanced against the risk of providing no added diagnostic or therapeutic value, creating unnecessary workup, patient worry and anxiety, and increased costs and diverting resources from more important healthcare work.

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