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Intramammary Findings on CT of the Chest – a Review of Normal Anatomy and Possible Findings

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Summary

Computed tomography (CT) is a frequently performed examination in women of all ages. In all thoracic CT examinations of the chest at least parts of the breasts are included. Therefore incidental breast pathology may be observed. It has been suggested that one out of 250 women undergoing chest CT will show a malignant incidental breast lesion. Given the high number of performed chest CT examinations, this contributes to a significant number of malignancies. In this review, after a brief discussion of the value of computed tomography in breast imaging, normal and pathologic findings are discussed to create awareness of this potential "black box" on chest CT.

MeSH Keywords: Breast • Incidental Findings • Tomography, Spiral Computed

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Background

Computed tomography (CT) is a frequently performed examination in women of all ages. In all thoracic CT examinations of the chest at least parts of the breasts are included. The focus of the examination is usually the lung parenchyma, the great vessels or the heart. Therefore the covered parts of the breast may receive less attention and incidental findings may be missed. As breast cancer is a common diagnosis with a lifetime risk of 12.4% a careful examination of the breast should be performed in women, especially in the age group covered by breast cancer screening programs in many countries (40–70 years) [1]. In this review the value of computed tomography in breast imaging as well as normal and pathologic findings are discussed to create awareness of this potential "black box" on chest CT.

The Value of Computed Tomography in Breast Imaging

The imaging of choice in suspected breast disease is usually mammography and ultrasound followed by magnetic resonance imaging (MRI) in complex or equivocal cases. There have been various reports about the value of CT of the female breast. It has been studied as an alternative to breast MRI, because of the limited access to MRI on a global scale and a growing number of patients with contraindications for MRI scanning (for example cardiac pacemakers). It has been shown that CT is less sensitive than MRI, which usually shows a sensitivity of more than 95% [1]. But dynamic CT with the use of contrast media of the breast showed also high sensitivities of 91%, 92.6%, and 93% in three studies [2–4]. In those studies a total of 310 patients were examined, i.e. CT of the breast may be an alternative to MRI in selected patients. The main limitation is the applied radiation, which hinders its use in younger or high-risk populations on a broader scale. The preoperative use of CT in addition to mammography and ultrasound increased breast conservation rates because of the better delineation of tumor extent [5]. Interestingly, dedicated breast CT and contrast-enhanced mammography have been recently introduced into clinical practice and showed promising results [6,7]. The use of contrast media facilitates the detection of malignant findings, because breast tumors show an increased contrast media uptake in comparison with the normal breast tissue (Figure 1). Especially in imaging of the young patients, radiation protection is important. The use of automatic tube current modulation and limitation of the field-of-view (for example exclusion of the lung apices in imaging for lung embolism) is mandatory. Low-dose protocols are also often used for lung parenchyma imaging. But with the use of low-dose protocols there is an increase in image noise, which usually impedes the assessment of the soft tissues. In these cases thick-sliced reconstructions or maximum-intensity projections may help to evaluate the breast tissue. Breast shielding to reduce the glandular

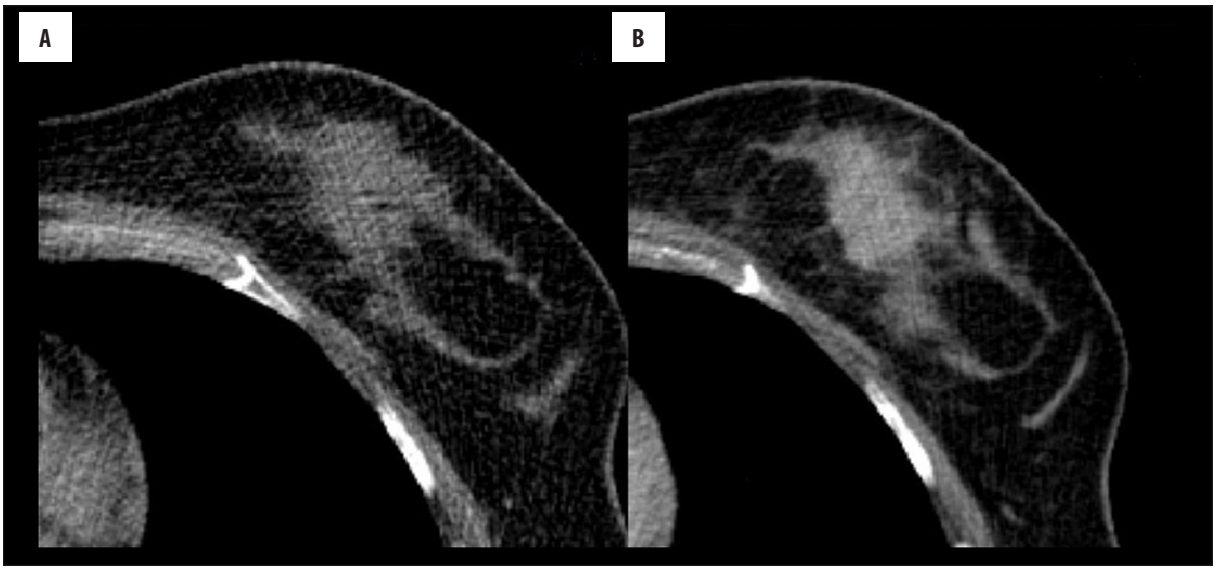

Figure 1. Breast cancer on CT without contrast media (**A**) and after the administration of iodinated intravenous contrast media (**B**). Without contrast there is a poorly defined mass only, the exact extension of the breast cancer can be seen with enhancement of the cancer.

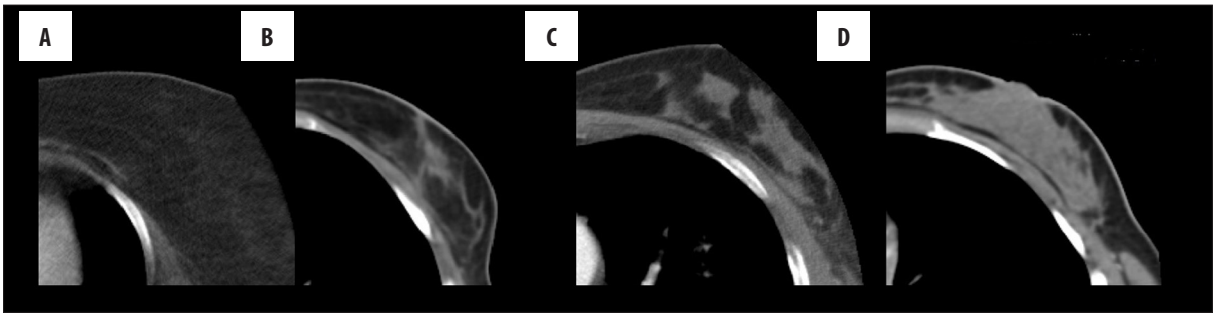

Figure 2. Different types of breast density on CT. (**A**) Entirely fatty, (**B**) scattered areas of fibroglandular density, (**C**) heterogeneously dense, (**D**) extremely dense.

dose of the female breast is now used in some departments during CT of the chest. These breast shields usually lead to beam hardening artefacts of the adjacent breast tissue, which makes the assessment of parts of the adjacent breast tissue nearly impossible. In conclusion, careful examination of the female breast, especially after application of contrast media, has the opportunity to detect an "occult", but clinically meaningful disease.

Frequency of Incidental Findings

Two large studies examined the frequency of incidental breast findings on chest CT. Surov et al. reported about 89 patients with incidental findings in 8105 chest CT examinations (1.1%) [8] and Monzawa et al. reported about 31 patients with incidental findings in 2945 patients (1.1%) [9]. The frequency of malignant findings was 0.4% and 0.3% in those two studies, i.e. one out of 250 women undergoing chest CT will show a malignant incidental breast lesion. Given the high number of performed chest CT examinations this contributes to a significant number of detected malignancies.

Normal Findings

In the updated 5th version of the BIRADS glossary four types of density are described for mammography and

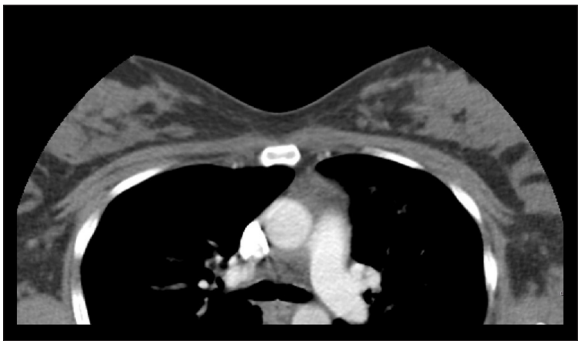

Figure 3. Extremely dense breast in a lactating women.

MRI: entirely fatty, scattered areas of fibroglandular density, heterogeneously dense, extremely dense (Figure 2) [10]. However, contrary to mammography, denser breast tissue does not reduce the sensitivity of MRI. With the use of contrast media with CT, density may not play such a significant role. But with CT there is no possibility of subtraction imaging which is used with MRI or contrast-enhanced mammography, i.e. mildly-enhancing lesions may be obscured. The use of dedicated window settings may optimize the detection of areas of contrast enhancement. The lactating breast usually is extremely dense (Figure 3). Sometimes in the postpartum period edematous changes

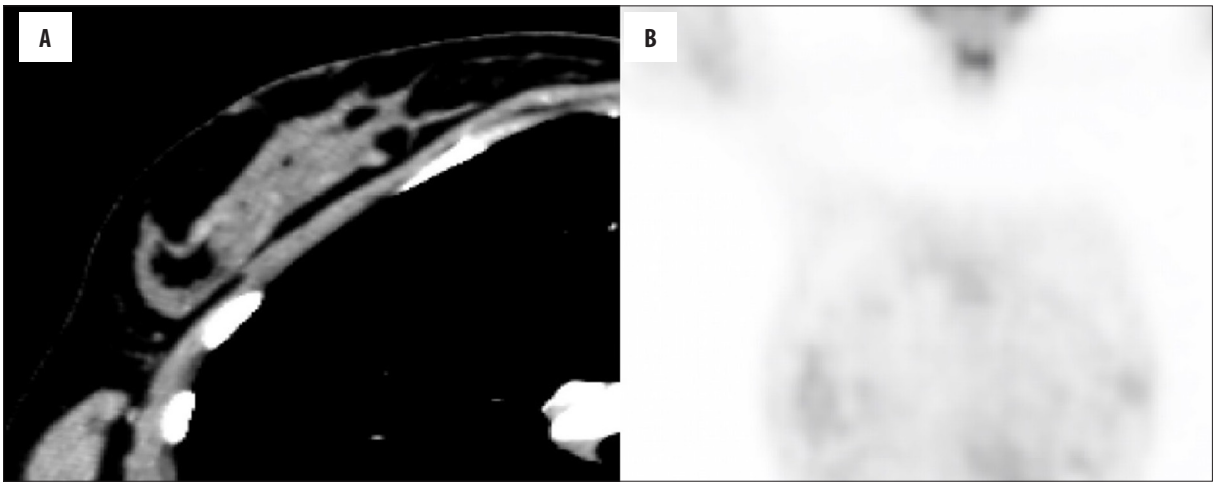

Figure 4. Small punctuate areas of contrast enhancement in the breast of a young women with lung cancer (**A**). Further work-up including PET (**B**) was unremarkable. These foci are a well-known appearance on MRI.

Figure 5. Macrocalcification of the left breast. Microcalcifications are not visible on routine chest CT.

and vascular congestion may be found [11]. Small punctuate areas or dots of enhancement, which cannot be evaluated further because of the small size are a well-known appearance on MRI of the breast. These foci are usually thought to represent a benign finding, but some authors argue for follow-up examinations to rule out small cancers. Rarely, these foci can also be found on CT after contrast media application (Figure 4) [12].

Benign Lesions

Because of the limited resolution of chest CT, with usual slice thicknesses of around 1 mm used for imaging of the chest, microcalcifications cannot been seen. Malignant microcalcifications, the hallmark of ductal carcinoma *in situ* on mammography are invisible on routine CT examinations. All punctuate calcifications seen on chest CT are therefore macrocalicifications and usually not worrisome (Figure 5). There are two types of benign tumors which can be diagnosed on chest CT: typical fibroadenomas with calcifications and fat necrosis (Figure 6). Typical fibroadenomas consist of an ovoid and sharply demarcated enhancing mass with calcifications. As it has been shown, fibroadenomas without calcifications cannot be reliably distinguished form malignant findings [13]. The limited resolution of routine CT may obscure discrete spiculations. Usually with chest CT imaging there is only one phase after contrast application, so several phases after contrast

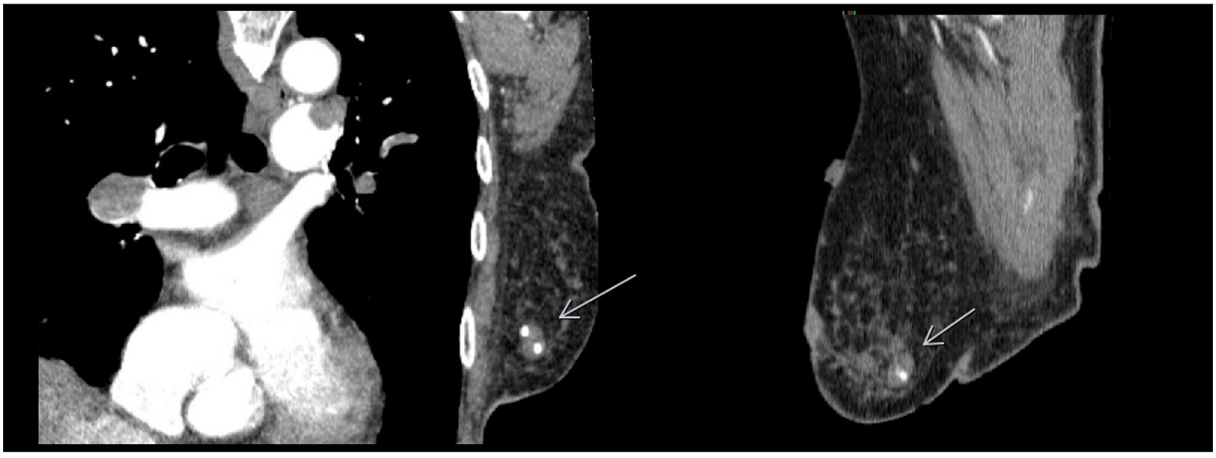

Figure 6. Typical fibroadenoma of the breast. A small enhancing lesion with calcifications can be seen. Note also the small cutaneous lesion (verruca). Chest CT was performed because of pulmonary embolism.

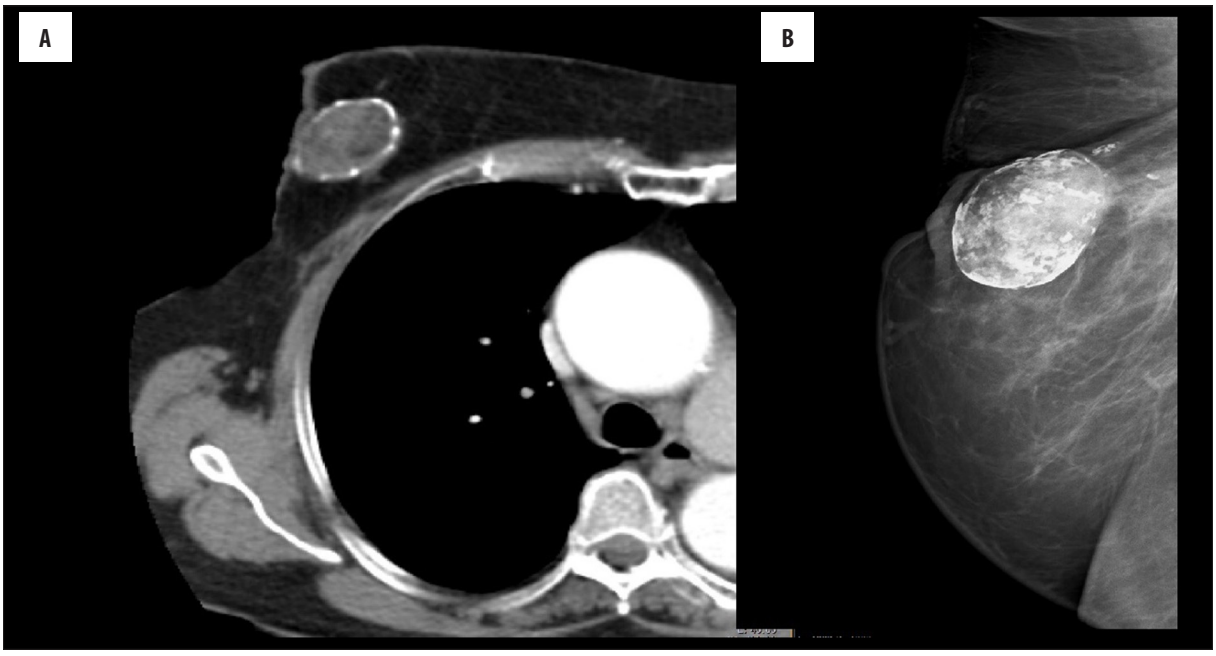

Figure 7. A large fat necrosis can be seen in this patient after breast conserving surgery. CT shows a large mass with central fatty areas and rim calcification (**A**). Mammographic correlation (**B**).

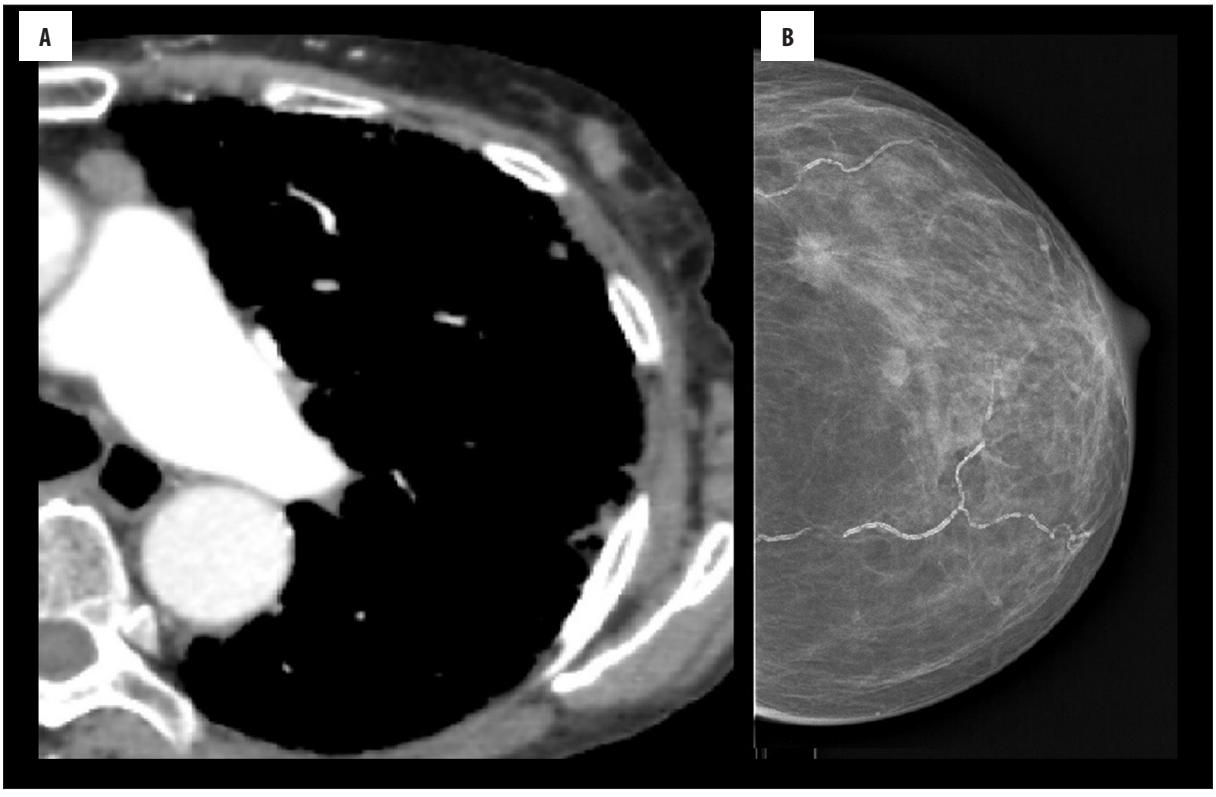

Figure 8. Incidentally found breast cancer on CT of the chest. An enhancing mass with irregular margins can be found in the left breast (**A**). Mammographic correlation (**B**).

injection, which can distinguish fibroadenomas from cancer on dynamic breast CT are not available. Another diagnosable lesion is fat necrosis. Typically, a mass with rim calcification and central areas of fat can be seen (Figure 7). Larger fat necrosis can be usually found after operation, i.e. after breast-conserving surgery for cancer.

Malignant Lesions

On CT breast cancers typically show an indistinct margin and contrast enhancement (Figure 8). These features strongly suggest malignancy [14]. On the other hand, as discussed above, the resolution of a standard CT may be

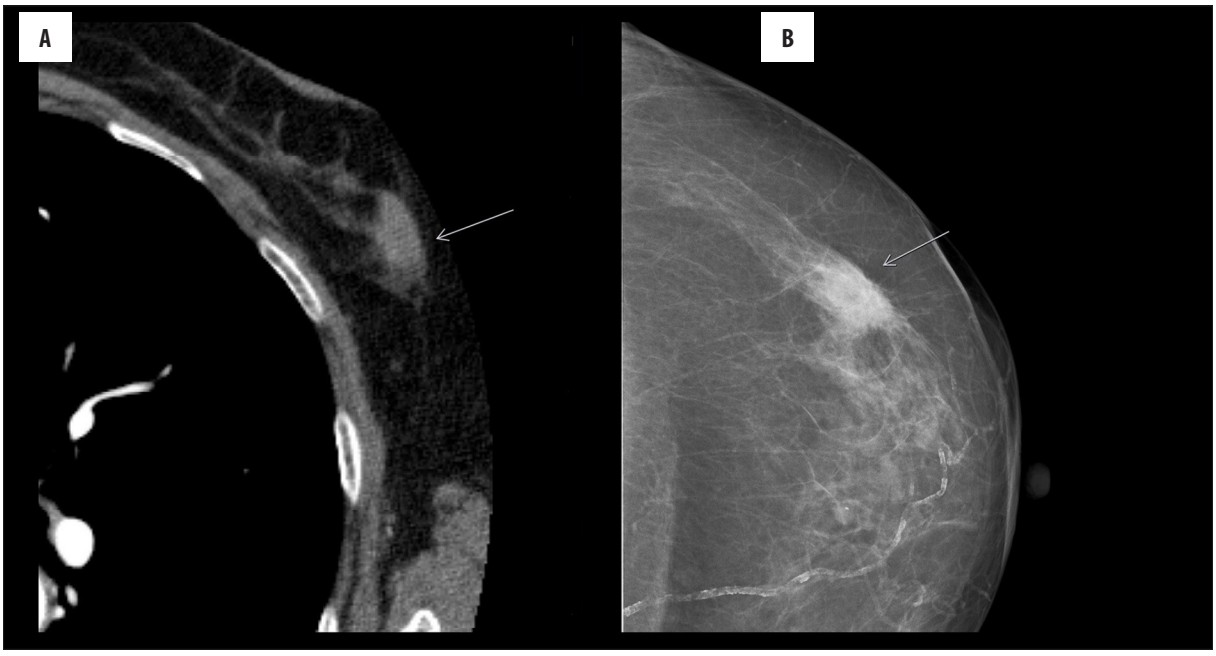

Figure 9. Another example of an incidentally found breast cancer. An ovoid enhancing mass can be found on CT without clear irregular margins (**A**). Mammography showed an irregular lesion (**B**). Biopsy revealed cancer.

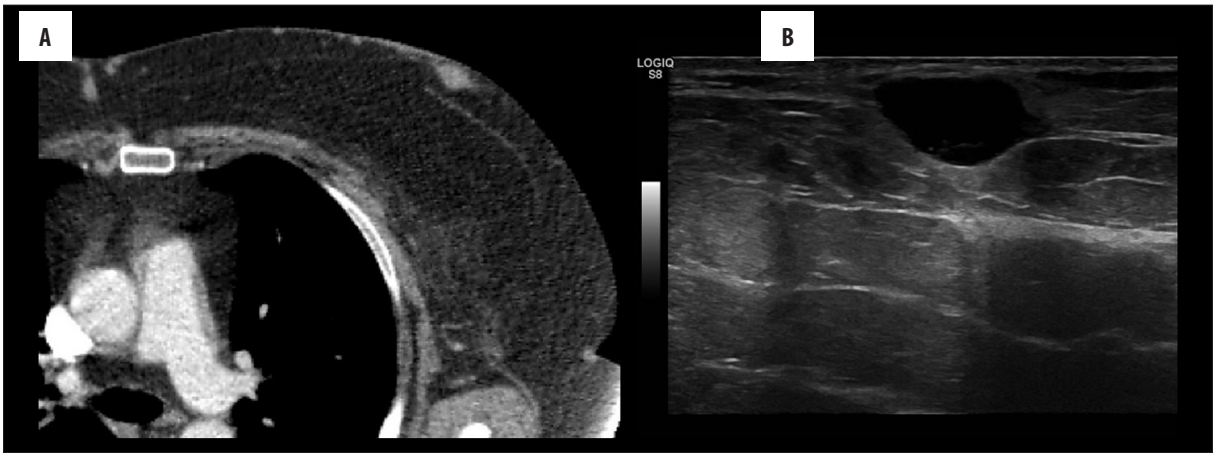

Figure 10. Recurrent breast cancer presenting as an ovoid enhancing mass on CT (**A**). There are no dedicated malignant features on ultrasound (**B**). Biopsy proved malignancy. Note the absence of glandular tissue after bilateral mastectomy and reconstruction with a deep inferior epigastric perforator (DIEP) – flap.

too low to show discrete irregularities of the margins. Therefore morphological features on CT are not pathognomonic and every enhancing mass without clearly depicted calcifications suggestive of fibroadenoma should undergo further work- up (Figures 9, 10) [15].

Postoperative Changes

Mastectomy was previously frequently performed in the surgical treatment of breast cancer and can be commonly seen in elderly women (Figure 11). Nowadays most cancers are operated with breast-conserving surgery [15]. Common findings after breast-conserving surgery include volume loss, architectural distortion, scar tissue and skin thickening (Figures 7, 12). Breast implants can be easily depicted on CT imaging. It has to be differentiated between implants for cosmetic purposes and after cancer surgery. For cosmetic reasons implants are often placed under the pectoralis muscle, therefore breast parenchyma can be seen (Figure 13). In the case of breast reconstruction after cancer surgery implants are usually placed above the pectoralis muscle. In this case normally no residual parenchyma can be seen. A common complication with implants is capsular fibrosis, which shows a progressive course from thickened capsular tissue and increased number of radial folds eventually leading to severe calcification (Figure 14). Another complication is rupture of breast implants. In intracapsular rupture the outer lining of the implant undergoes rupture, but the surrounding fibrous capsule of the implant which is formed after implantation remains intact and the silicone cannot migrate into the soft tissues of the breast. The classic sign for this pathology on magnetic resonance imaging (MRI) is the linguine sign, which can be occasionally seen on CT imaging (Figure 15) [16].

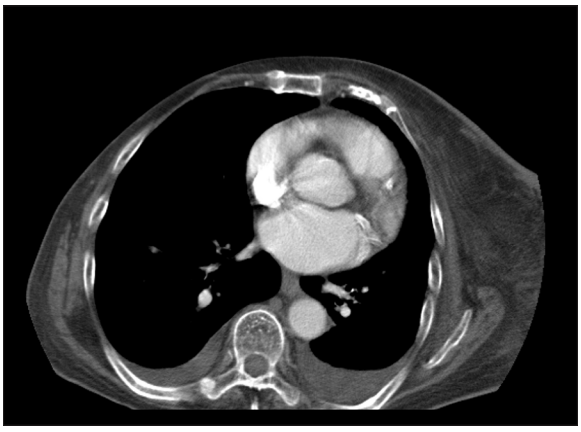

Figure 11. Mastectomy on the right side. Note the edematous changes of the left breast with concomitant skin thickening and pleural effusions because of heart failure.

Figure 12. Performed breast-conserving surgery on the right side. The right breast is smaller than the left one and scar tissue extending onto the thoracic fascia can be seen.

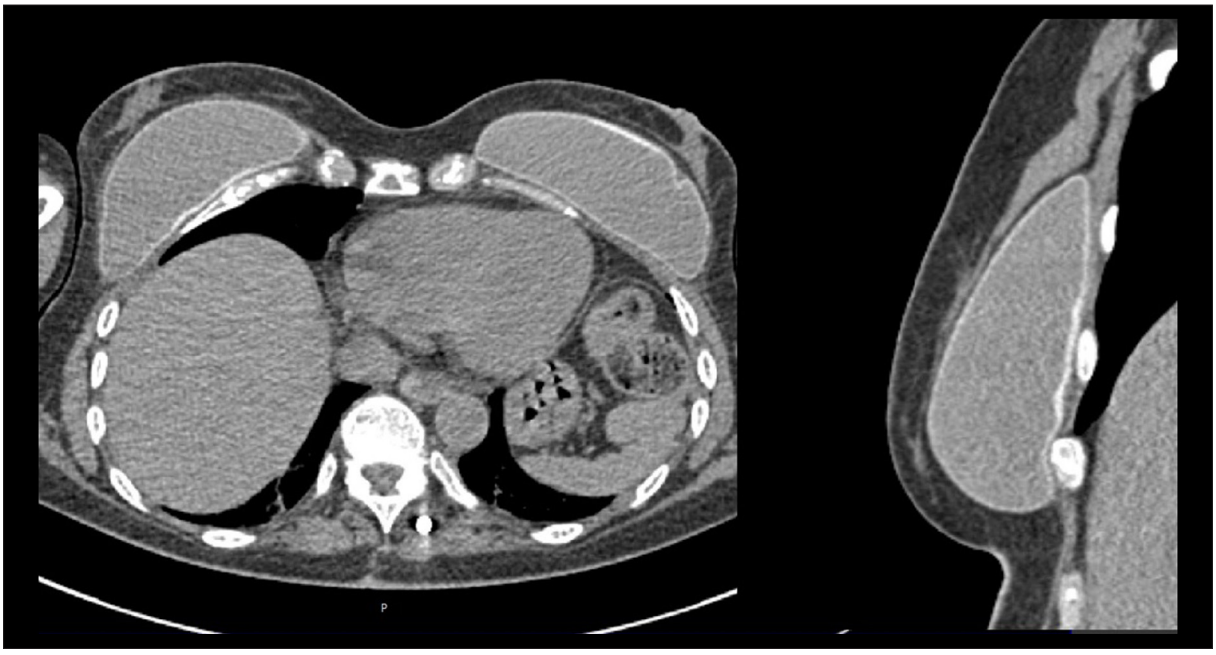

Figure 13. Breast implants for cosmetic purposes. These bilateral implants are placed under the pectoralis muscle. Breast parenchyma can be seen. The left implant shows a small radial fold, a usual finding with breast implants.

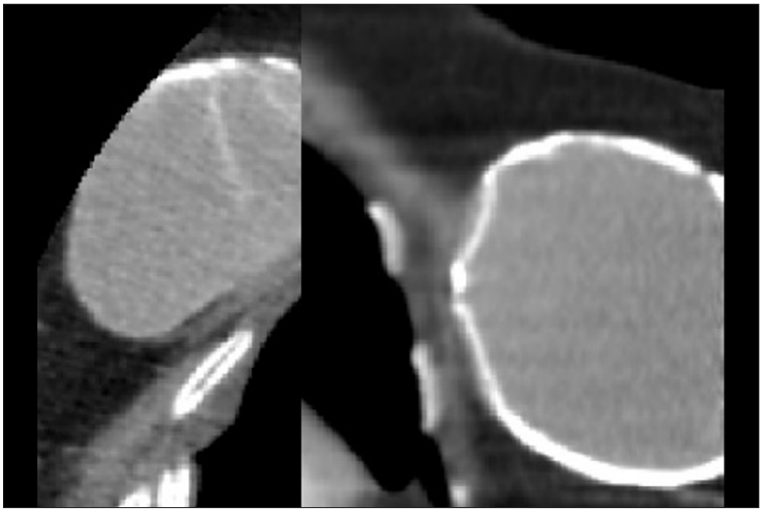

Figure 14. Late-stage capsular fibrosis with severe calcifications of a breast implant.

Figure 15. Intracapsular rupture of a silicone implant. The collapsed capsule forms the classic linguine sign.

Intramammary Findings of a Systemic Disease

Edema of the breast parenchyma can be seen in congestive heart disease, generalized edema with inflammation or renal failure as well as hypoproteinemia. In these cases the fat tissue of the breast shows a diffuse increase in density and there is usually skin thickening (Figure 11). In severe cases of arteriosclerosis vascular calcifications can be found. A variety of breast changes in systemic diseases has been described with mammography, but has until now not been reported for CT imaging [17].

Suggestions for the Work-Up of Breast Incidentalomas

As described above all incidentally seen enhancing masses on chest CT without pathognomonic appearance of fibroadenomas (coarse calcifications) should undergo further work-up. We usually advise mammography and dedicated ultrasound within the hospital stay. If possible, the correlation with existing mammography images or previous chest CT examinations should be obtained. If the lesion is really new or is getting larger it should be regarded as a suspicious finding. If an enhancing mass can be correlated with ultrasound, tissue sampling with ultrasound-guided biopsy is usually the next examination of choice.

Conclusions

Incidental breast lesions on chest CT are quite a common appearance. The data suggest that one out of 250 women undergoing chest CT will have a malignant breast "incidentaloma". Therefore reporting radiologists have an opportunity to detect occult cancers and should therefore also focus on the examined parts of the breast parenchyma to detect a clinically meaningful disease.

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