Mammographic calcifications: anatomical/pathological classification and differential diagnosis

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Introduction

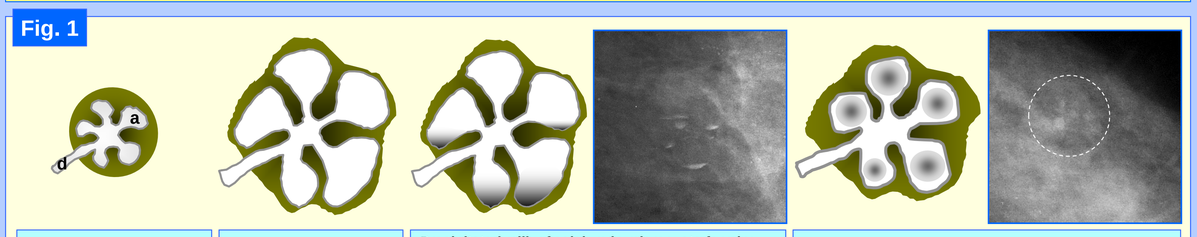
Breast calcifications are a common finding at routine screening mammography. Many of these calcifications clearly represent benign or malignant breast disease, but in a significant number of cases they remain indeterminate. The goal of the present exhibit is twofold: (1) to present an anatomical/pathological classification of the most common calcifications to explain their morphology and distribution pattern; (2) to provide a convenient mammographic classification system to increase the diagnostic accuracy in the differentiation of mammographic calcifications.

ANATOMIC CLASSIFICATION

Lobular Calcifications

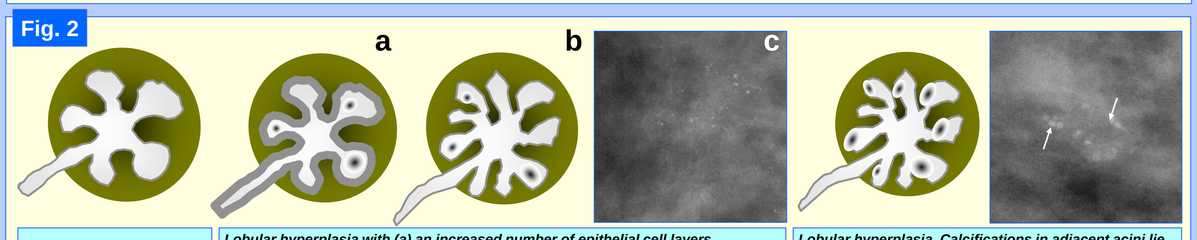
Lobular calcifications are found predominantly in cystic and benign hyperplastic ("fibrocystic") changes. The former include microcysts (microcystic adenosis) and milk of calcium cysts (Fig. 1). The latter include adenosis, epitheliosis (Fig. 2) and slerosing adenosis (Fig. 3).
Calcifications in invasive or in situ lobular carcinoma are non-specific.

Fig. 1



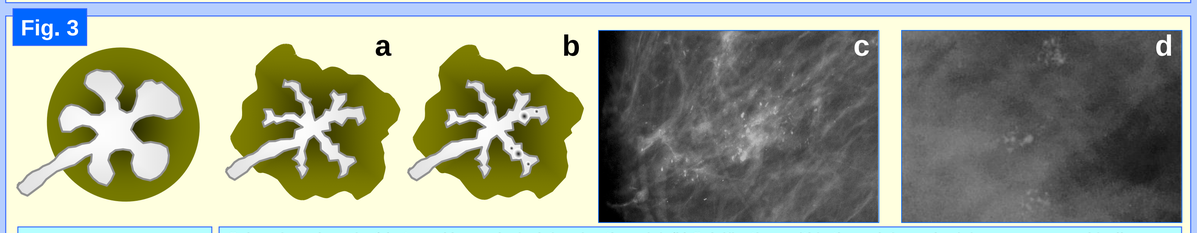
Normal lobule: terminal ductule (d) with several acini (a)	Microcysts: enlarged acini	Precipitated milk of calcium in microcysts forming "teacup" calcificitions. A lateral mammogram shows up to 5 mm large, isolated or scattered "teacup"-calcifications, which are usually bilateral.	Precipitated milk of calcium in microcysts. A craniocaudal mammogram shows round or faceted calcifications with denser center and blurred margins.

Fig. 2



Normal lobule : terminal ductule with several acini	Lobular hyperplasia with (a) an increased number of epithelial cell layers (epitheliosis) or (b) an increased number of acini (adenosis). The corresponding mammogram (c) shows isolated or scattered regular punctate calcifications (casts of regular acini) in round or oval groups up to 5 mm large.	Lobular hyperplasia. Calcifications in adjacent acini lie tightly grouped in a small area and are separated by a lucent stromal septum (arrows). They form the so-called morula or rosette appearance.

Fig. 3

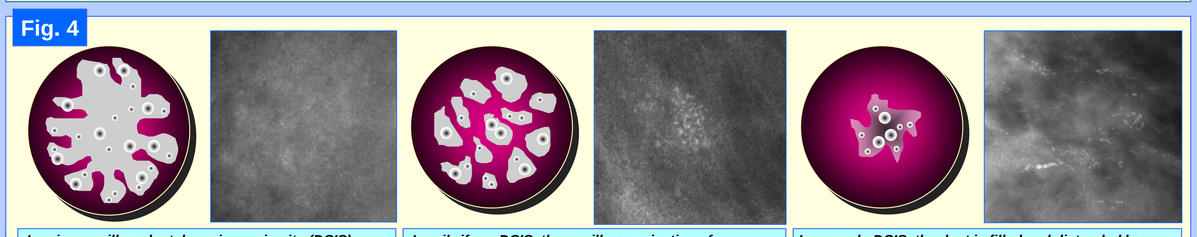


Normal lobule : terminal ductule with several acini	Sclerosing adenosis: (a) stromal hyperplasia deforming the acini. (b) Calcifications within these deformed acini are mammographically visible as (c) irregular punctate calcifications (casts of irregular acini), which are indistinguishable from malignant calcifications. (d) On occasion, the presence of multiple identical groups of irregular punctate calcifications in one or both breasts may suggest sclerosing adenosis; however, this sign is by no means pathognomonic.

Ductal Calcifications

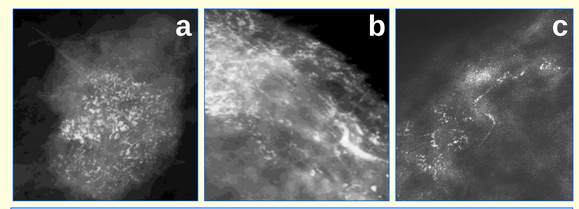
Ductal calcifications are most frequently associated with ductal carcinoma (Fig. 4) or with benign changes such as secretory disease (Fig. 5). Their shape and disposition are the result of the condition of the duct of which they are a "cast".

Fig. 4



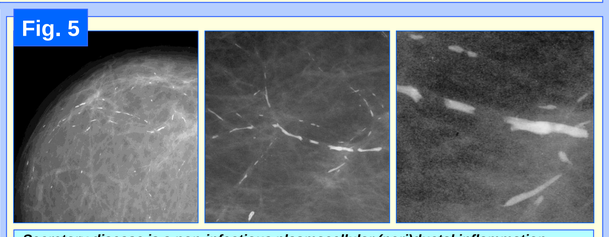
In micropapillary ductal carcinoma in situ (DCIS) small cells produce papillary growths into the ductal lumen that may contain milk of calcium: hardly visible punctate calcifications ("dust").	In cribriform DCIS, the papillary projections form cribriform spaces (like a "sieve") within the ductal lumen containing milk of calcium: small pleomorphic granular calcifications.	In comedo DCIS, the duct is filled and distended by malignant cells with central necrosis. Distrophic calcifications in the latter form irregular punctate or linear calcifications with branching configurations.

Fig. 5



Comedo DCIS: irregular calcifications of varying size, density and shape. (a) Irregular calcifications within a mass, (b-c) coarse irregular calcifications in clearly ductal and/or branching arrangement.

Fig. 5

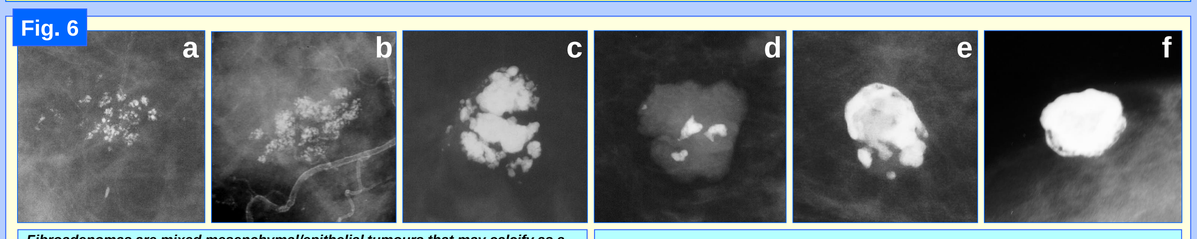


Secretory disease is a non-infectious plasmacellular (peri)ductal inflammation accompanying duct ectasia. It results in characteristic coarse continuous needle-like ductal calcifications. They are smooth-bordered and lie in a ductal arrangement.

Extraductal Calcifications

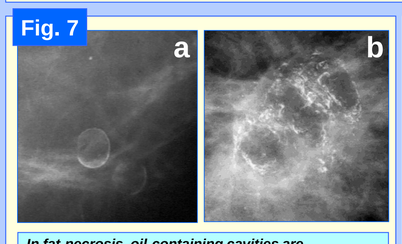
Extraductal calcifications are found in fibroadenomas (Fig. 6) and in the extraductal stromal tissue. The latter includes fat necrosis (Fig. 7), vascular calcifications (Fig. 8), foreign bodies (Fig. 9), skin calcifications (Fig. 10) and pseudocalcifications (Fig. 11).

Fig. 6



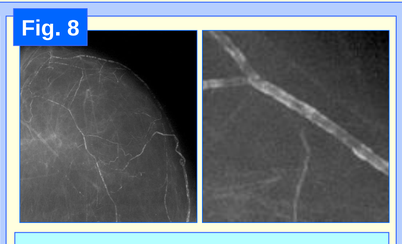
Fibroadenomas are mixed mesenchymal/epithelial tumours that may calcify as a result of mucoid degeneration. (a) Early calcifications may be punctate and irregular, (b) but typically become coarse and concentrated in a round/oval group.(c) Ultimately, so-called "popcorn"-calcifications are formed.	Calcifying fibroadenoma: (d) coarse irregular calcifications within a well-defined lobulated mass. (e) Progression into "popcorn" calcification and (f) ultimately complete calcification of the fibroadenoma.

Fig. 7



In fat-necrosis, oil-containing cavities are surrounded by a fibrous granulomatous capsule that may calcify, forming (a) regular "egg-shell" or (b) irregular lucent-centered calcifications.

Fig. 8

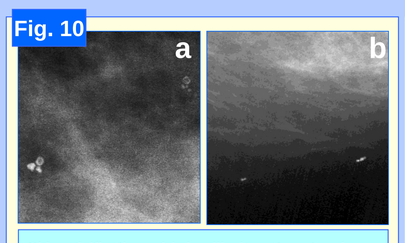


Vascular calcifications: parallel linear calcifications ("tram-line" calcifications). They do not follow the course of ductal structures.

Fig. 9

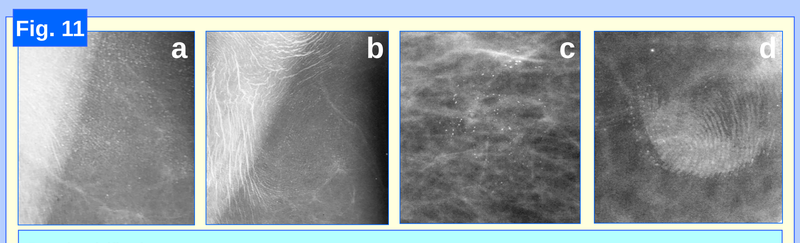
Foreign-body calcifications: calcified suture material.

Fig. 10



Skin calcifications: (a) ring-like lucent-centered calcified sebaceous glands. (b) The dermal origin can be confirmed using tangential beam imaging.

Fig. 11



Pseudocalcifications: (a) powder or (b) ointment on the skin (both digital and film-screen mammography); (c) Dust, defects (pick-off) or (d) fingerprints on the film (film-screen mammography).

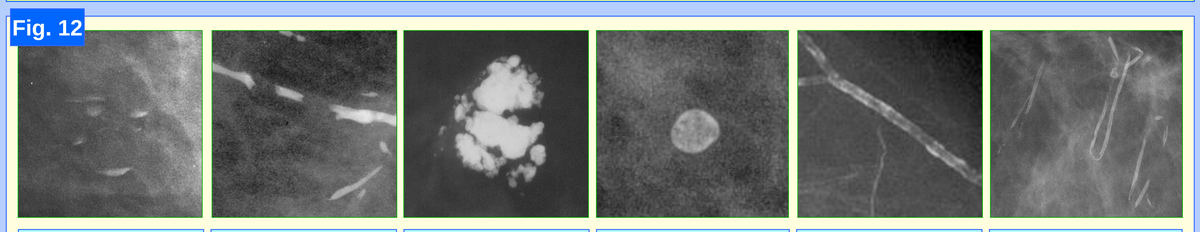
MAMMOGRAPHIC CLASSIFICATION

Benign — Indeterminate — Malignant

Pathognomonic Calcifications

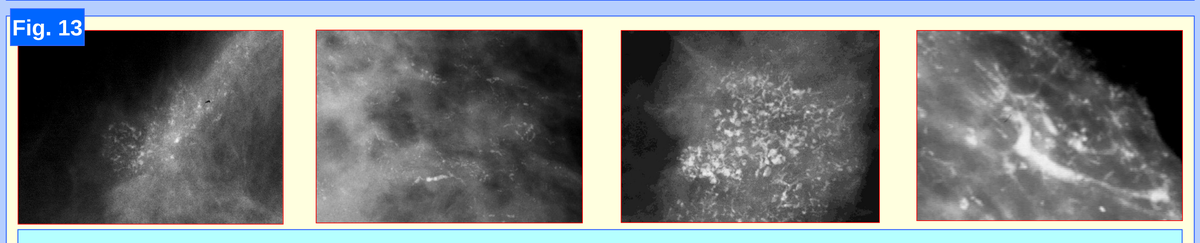
Many calcifications have features that allow confident categorization into benign (Fig. 12) or malignant (Fig. 13) types.

Fig. 12



Tea-cup calcifications: microcystic adenosis.	Continuous smooth-walled needle-like calcifications: secretory disease.	"Popcorn"-calcification: calcified fibroadenoma.	Lucent centered "egg-shell" calcification: calcified oil-cyst (fat-necrosis).	"Tram-line" calcifications: calcified blood vessels.	Calcified foreign bodies.

Fig. 13



Irregular punctate or linear calcifications of varying size, density and shape with branching configurations.

Indeterminate Calcifications

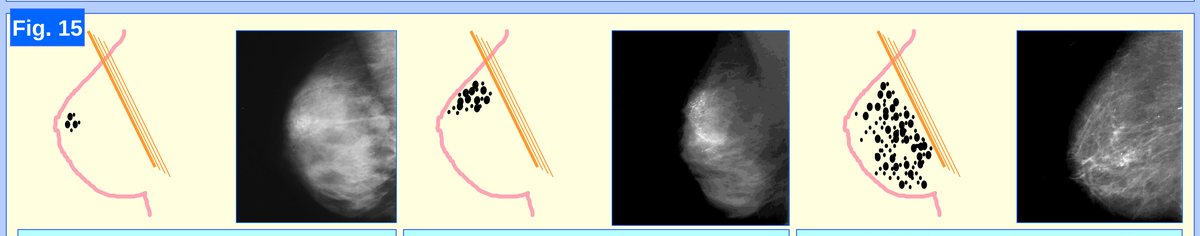
The remaining calcifications lack pathognomonic features and are called "indeterminate". They can, however, be further characterized on the basis of morphology of the individual calcifications* (Fig. 14), distribution pattern (Fig. 15), associated anamnestic and clinical findings and evolution over time (Fig. 16).

*Le Gal M, Chavanne G, Pellier D. Bull Cancer 1984;71:57-64.

Fig. 14

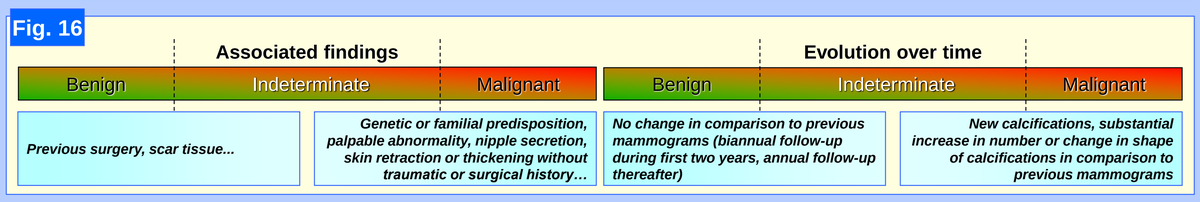
Le Gal 1: round calcifications: fat necrosis, calcified cysts, dermal calcifications…	Le Gal 2: regular punctate: adenosis, epitheliosis, early fibroadenoma, early ductal carcinoma...	Le Gal 3: very small ("dust"): micropapillary/cribriform ductal carcinoma, adenosis, epitheliosis…	Le Gal 4: irregular punctate: ductal carcinoma, slerosing adenosis, early fibroadenoma…	Le Gal 5: irregular linear ("vermicular"): ductal carcinoma

Fig. 15



Clustered calcifications (>5/cm²). One solitary cluster raises suspicion, especially if the cluster is triangular or irregular (not rounded or oval).	Segmental calcifications occur in (part of) a segment of the breast (probably a duct and its branches) and are worrisom.	Scattered calcifications occurring throughout (diffuse) or in several parts of the breast (regional), not necessarily following the course of ductal structures, tend to be benign, especially if bilateral.

Fig. 16



Previous surgery, scar tissue...	Genetic or familial predisposition, palpable abnormality, nipple secretion, skin retraction or thickening without traumatic or surgical history…	No change in comparison to previous mammograms (biannual follow-up during first two years, annual follow-up thereafter)	New calcifications, substantial increase in number or change in shape of calcifications in comparison to previous mammograms

Conclusion

Pathognomonically benign calcifications need no further work-up and pathognomonically malignant calcifications should be biopsied.
The choice between follow-up or biopsy for indeterminate calcifications should be the result of careful analysis of individual morphology of the calcifications and their distribution pattern, with incorporation of anamnestic and clinical information and evolution over time (if available).

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