2 Ultrasound Features of Thyroid Lesions

There are many different features indicating a certain benign or malignant tumor type, but many of these are overlapping signs. Combining several features is considered to give the best result. Ultrasound features of benign lesions are often described as a diffusely enlarged gland, a well-circumscribed inhomogeneous hyper- or isoechoic solid lesion, a semi-solid or predominantly cystic lesion, multinodular lesions, and so forth. US features suggestive of malignant thyroid tumors have been described as follows: microcalcifications, hypoechogenicity, a taller than wide lesion, predominantly solid composition, irregular borders, absence of peripheral halo, intranodular hypervascularity, and regional lymphadenopathy [4,8,9]. No single US feature has both a high sensitivity and a high positive predictive value for thyroid carcinoma. The different malignant tumors have to some degree a different appearance on US.

"Comet Tail" Crystals

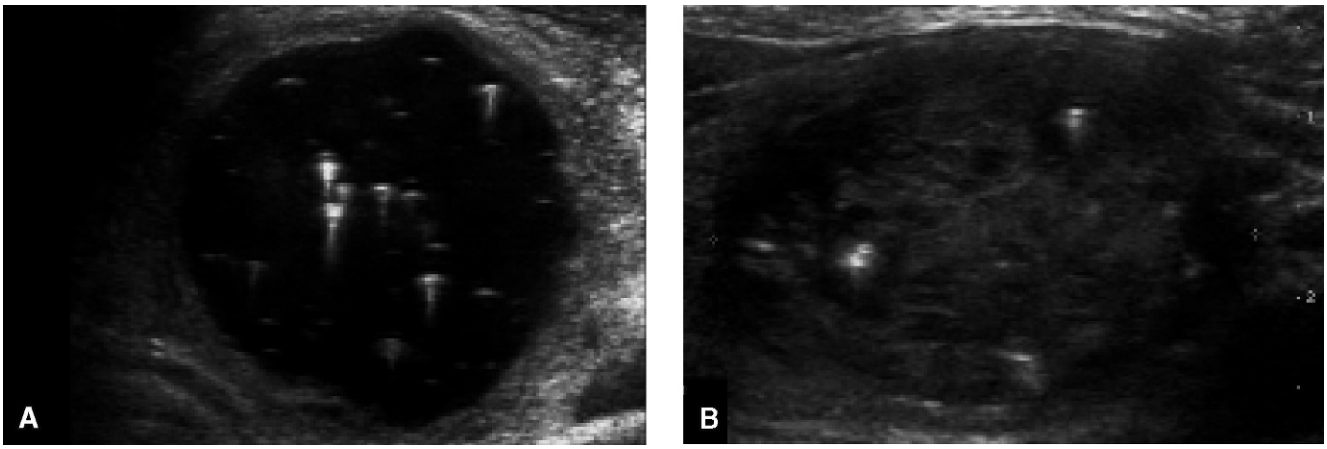

Figure 2-1. "Comet tail" crystals are highly echogenic, tiny, almost shiny foci, often with white tails, seen within both solid and cystic lesions that represent condensed colloid [4,6,7]. The white tail is a result of reverberation artifacts. **A**, Cystic Colloid nodule. **B**, Papillary thyroid carcinoma.

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Calcifications

Calcifications are described as micro-, coarse, or “eggshell” calcifications.

Microcalcifications

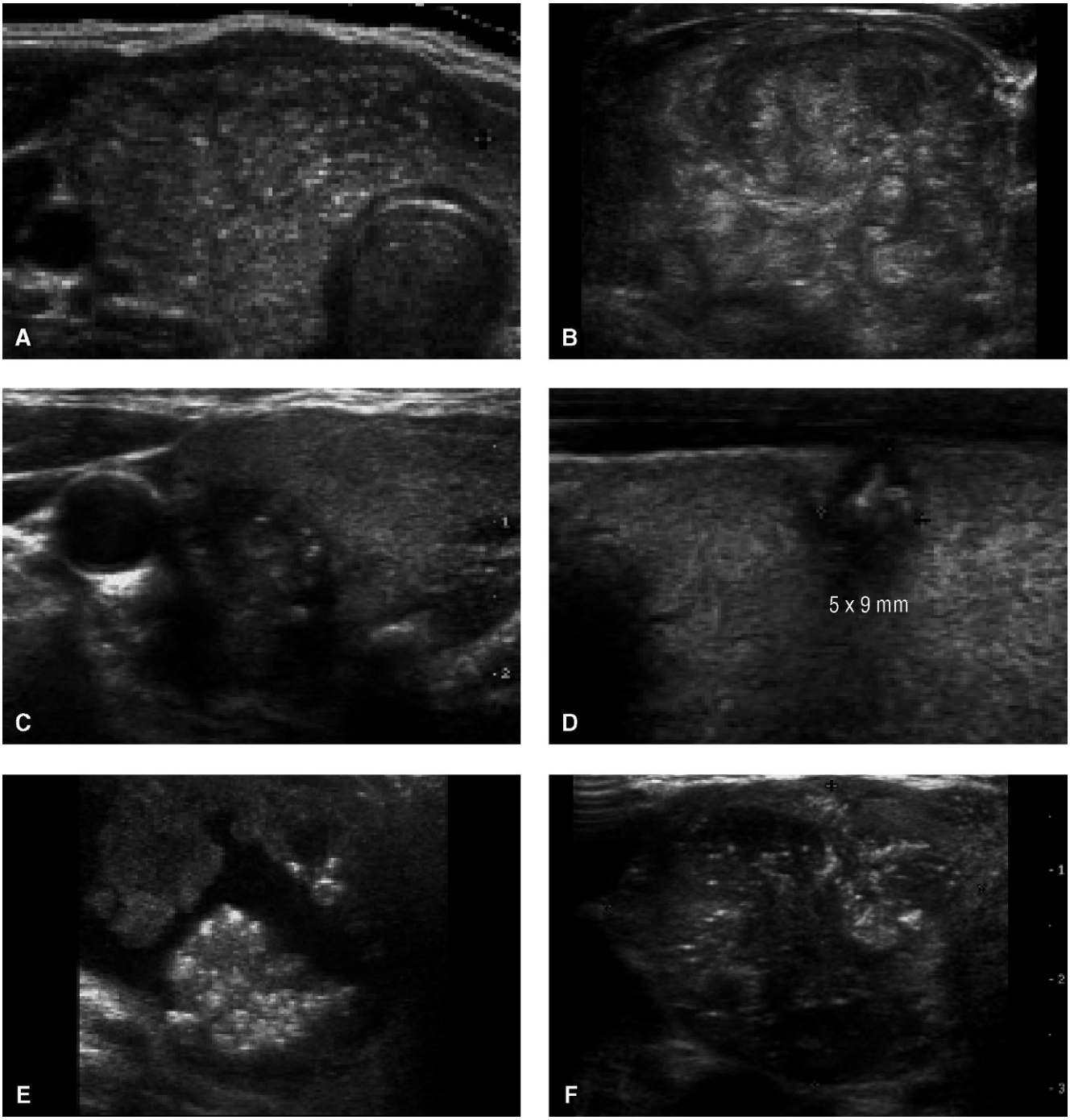

Figure 2-2. Microcalcifications are defined as punctate, highly echogenic, but somewhat pale nonshadowing discrete foci. They are thought to represent calcified psammoma bodies or granular amorphous deposits of calcium [4,10]. If they are innumerable or located in small groups, the tumor is highly suspicious for being a papillary carcinoma. Microcalcifications are also seen in medullary carcinoma, but they tend to be more coarse and with more irregular shape than in papillary carcinoma [6,7,10]. Often a few microcalcifications are also found in other malignant and benign tumors. **A**, Papillary thyroid carcinoma (PTC), innumerable. **B**, PTC, clusters. **C–E**, PTC. **F**, Medullary thyroid carcinoma.

Coarse calcifications

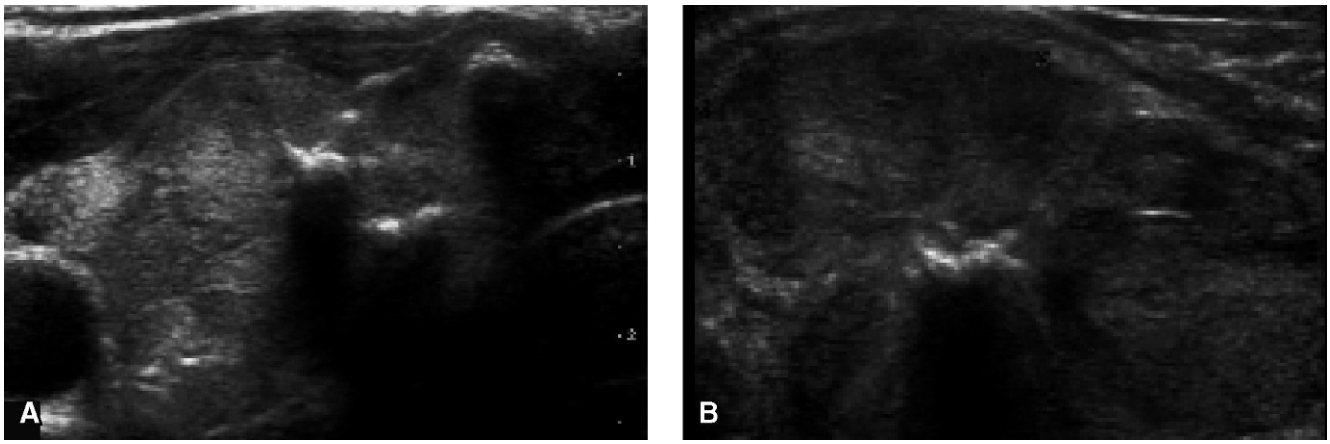

Figure 2–3. Coarse calcifications are defined as large, highly echogenic foci with irregular borders and acoustic shadow. They may appear as one large calcification or a cluster of smaller calcifications. They are suspicious for malignancy, especially if they are located in the central part of the tumor, but they are also often seen in nodular goiter [8,10,–13]. There is no exact distinction between the largest microcalcifications and the smallest coarse calcifications. Calcified psammoma bodies will probably always be tiny, but granular amorphous deposits of calcium may vary in size. **A**, Papillary Thyroid Carcinoma. **B**, Follicular thyroid carcinoma.

"Eggshell" calcifications

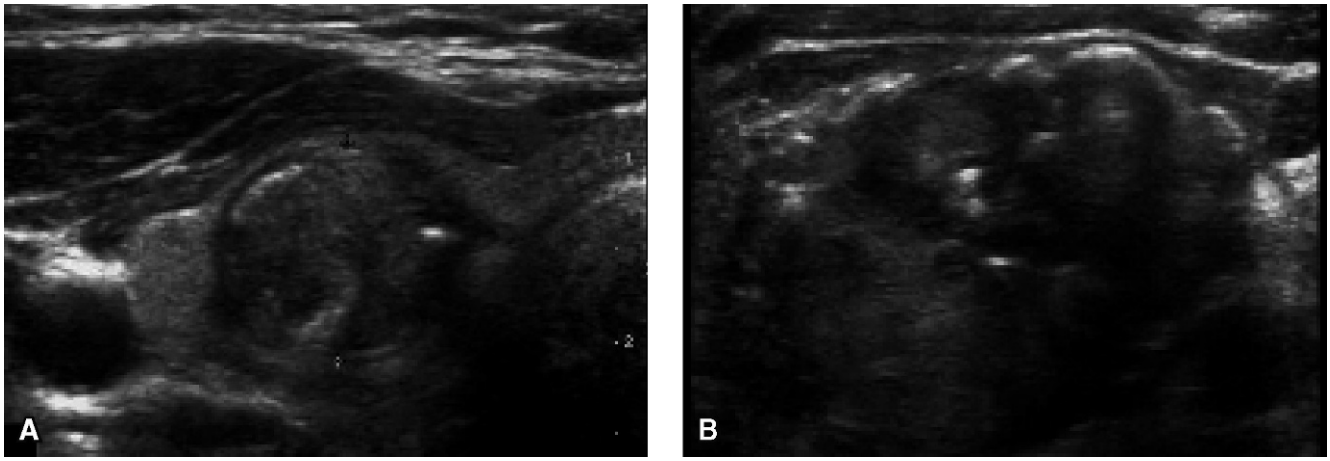

Figure 2–4. "Eggshell" calcifications are thin, peripherally located calcifications that indicate benignity and are usually due to degenerative changes in goiterous nodules [6], but can also be found in malignant tumors. **A**, Papillary thyroid carcinoma. **B**, Colloid nodule.

Histologic morphology

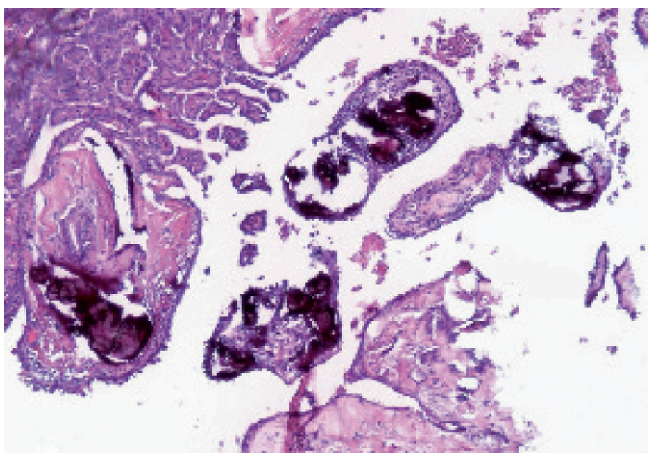

Figure 2–5. From lesions with coarse calcification, "eggshell" calcification, and "comet tail" crystals the histology specimen sometimes contains calcifications irregular in form and shape, in contrast to the true psammomma bodies one may find in specimens from papillary thyroid carcinomas (PTCs) that are circular with concentric rings. Cytology: microcalcification bodies in PTC.

Echogenicity

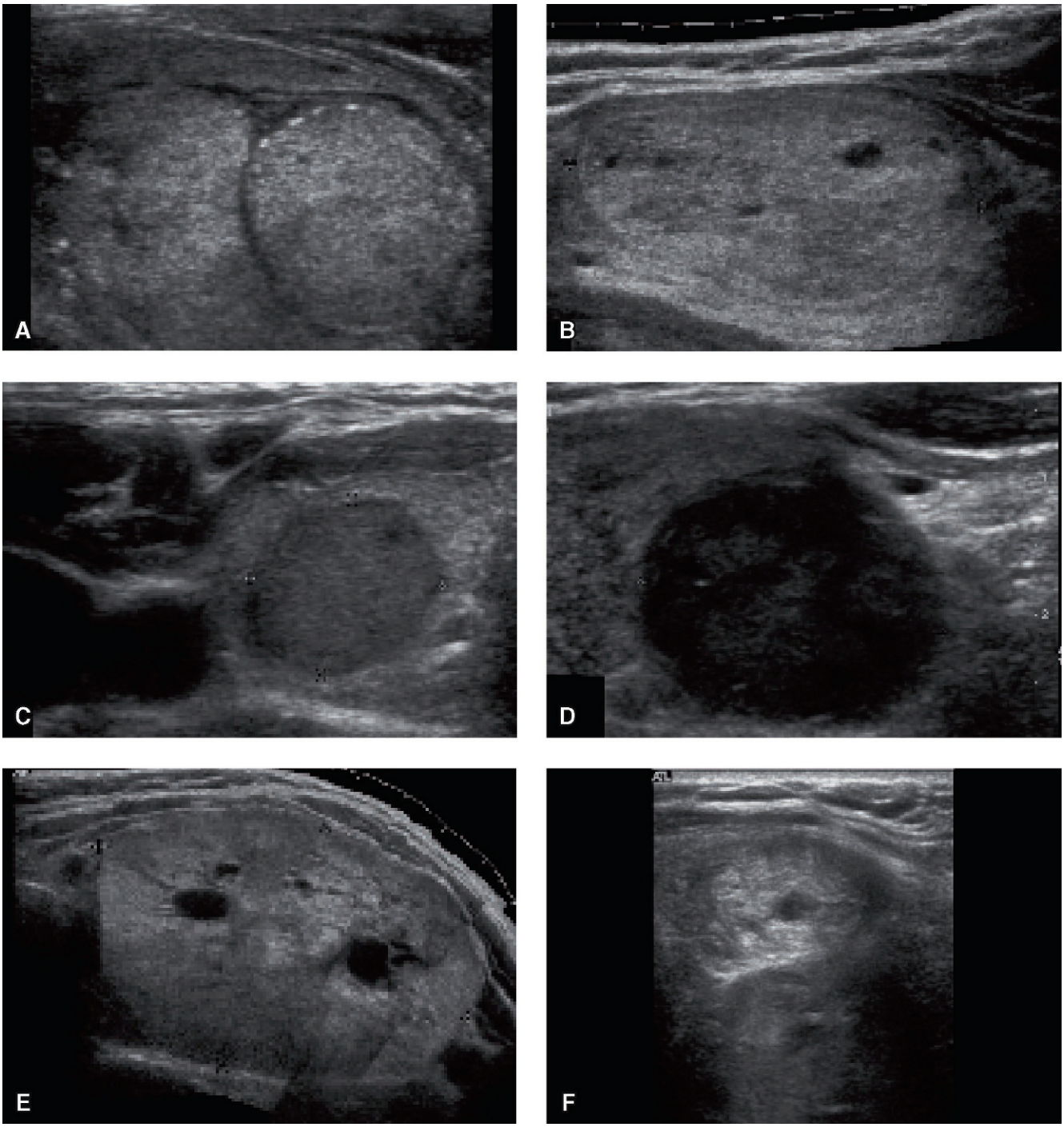

Figure 2–6. Lesions are described as hyperechoic, isoechoic, hypoechoic, anechoic, or with mixed echogenicity. Benign lesions are often hyper- or isoechoic or with mixed echogenicity compared with the echogenicity in the normal tissue of the thyroid gland; malignant tumors are most often hypoechoic [4–7]. A highly hypoechoic lesion is strongly suspicious for malignancy. There is, however, a lot of overlap between benign and malignant lesions. Cystic areas may be either anechoic or hypoechoic depending on the content. **A**, Hyperechoic (colloid nodule [CN]). **B**, Isoechoic (CN). **C**, Hypoechoic (medullary thyroid carcinoma). **D**, Strongly hypoechoic (follicular variant of papillary thyroid carcinoma). **E** and **F**, Mixed echogenicity (CN).

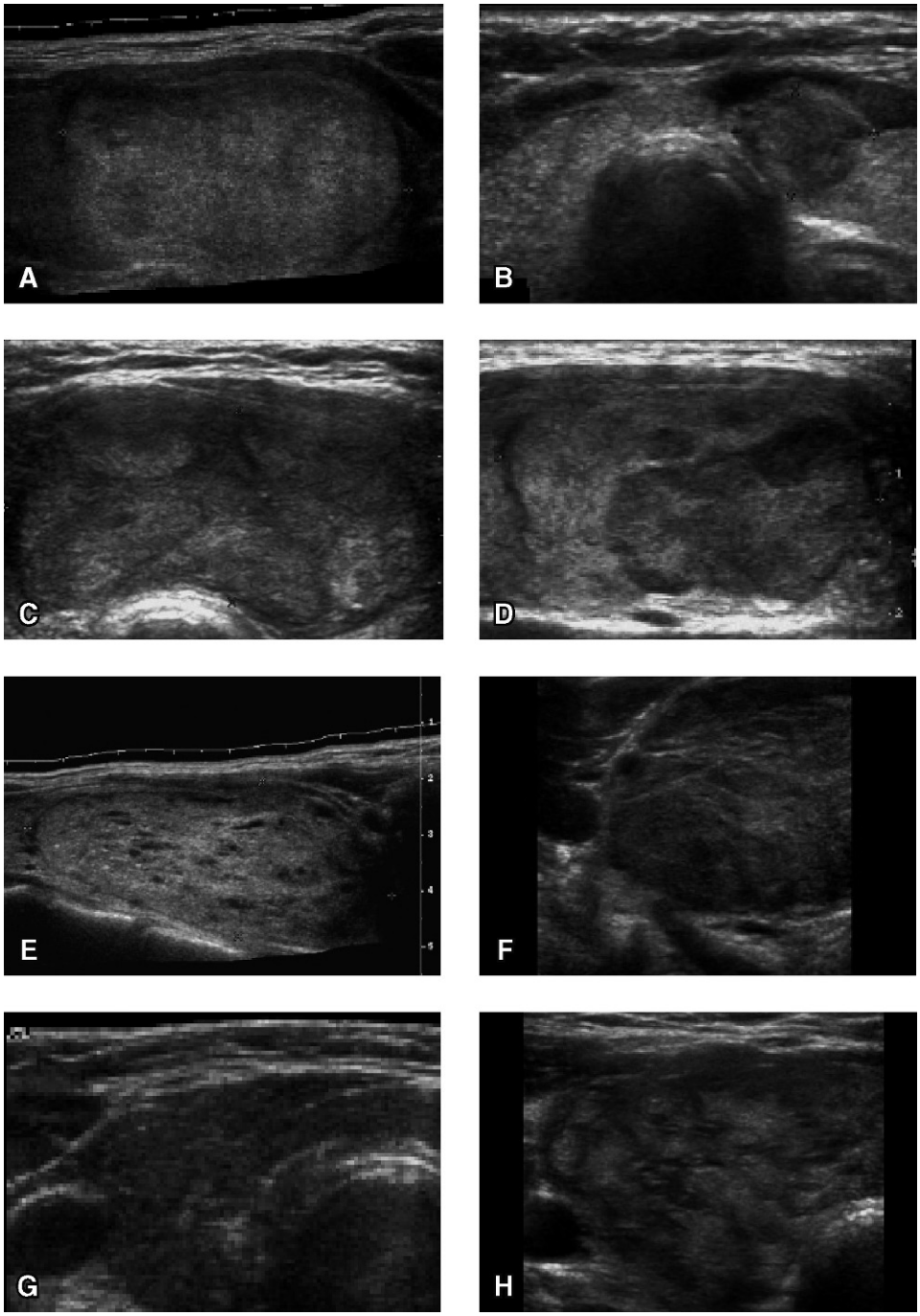

Figure 2–7. Echo pattern or echo texture is described in different ways by different authors. The pattern can be homogeneous or heterogeneous, regular or irregular. It can be lobulated, nodular or granular, spongy or honeycomb-like [6]. A homogeneous echo pattern indicates a benign tumor, and a heterogeneous echo pattern is usually seen in malignant lesions. A lobulated echo pattern may indicate a follicular tumor. Both predominantly large nodular patterns and small nodular patterns are found in goiter, but small nodular and granular patterns are also seen in thyroiditis [6,10]. Linear bright echoes within an enlarged hypoechoic thyroid lobe, so-called "coarse septations", are sometimes found in Hashimoto's thyroiditis. They are caused by fibrous bands [6,10]. Another echo pattern that may be of importance in distinguishing different tumors is geographic echo pattern. This pattern consists of sharply marginated areas of different echogenicity within the tumor. We have found this echo pattern especially in follicular variant of papillary thyroid carcinoma (FVPTC), but also in follicular tumors. **A**, Homogeneous (follicular adenoma [FA]). **B**, Heterogeneous (papillary thyroid carcinoma [PTC]). **C**, Lobulated (FA). **D**, Geographic (FVPTC). **E**, Spongy (colloid nodule). **F**, Coarse septations (lymphoma). **G**, Granular (thyroiditis). **H**, Nodular (thyroiditis).

Hypoechoic Halo

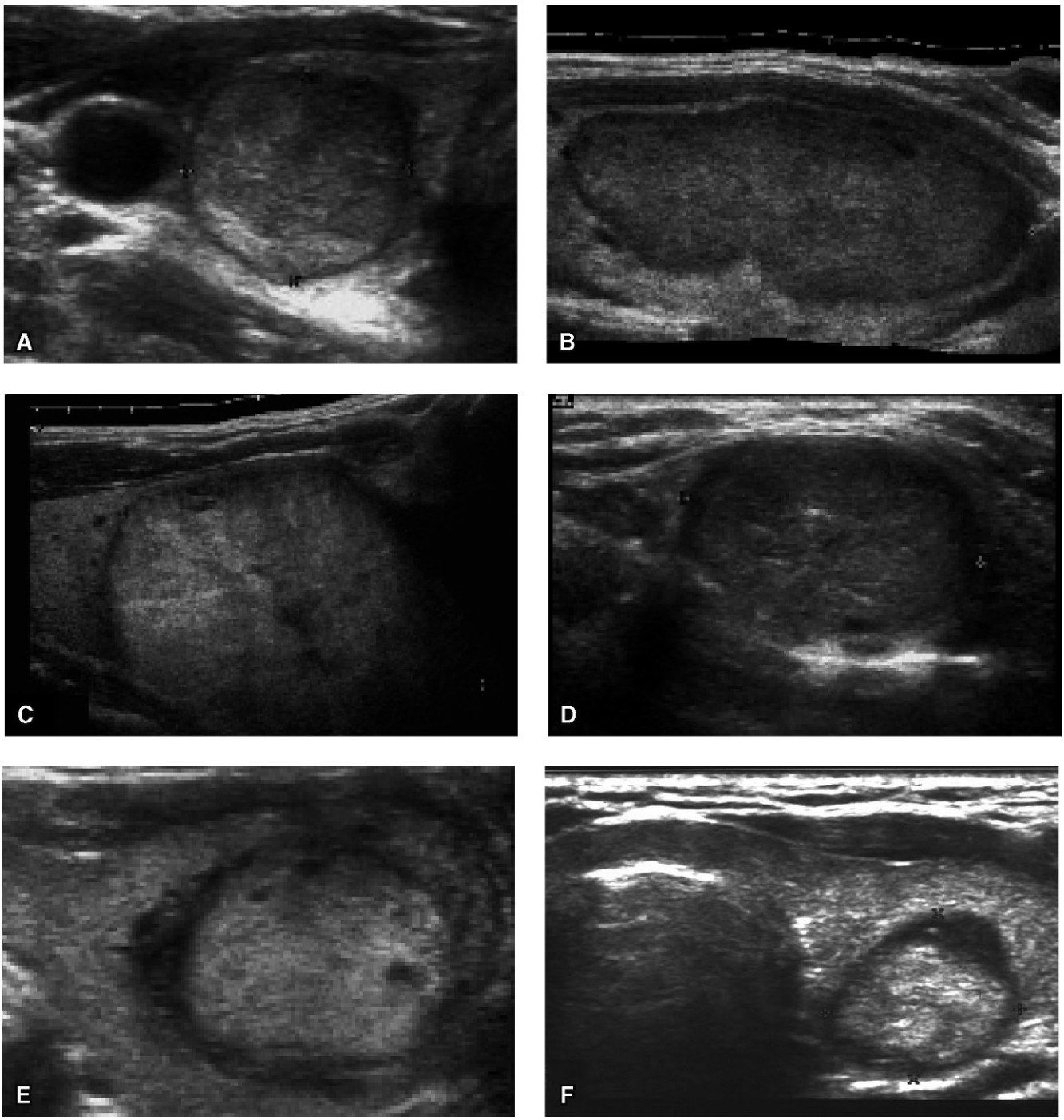

Figure 2–8. Using color Doppler, the peripheral hypoechoic halo especially found in follicular tumors represents peripheral vessels adjacent to the capsule [6,7]. A thin, even halo with a thin vascular rim is strongly indicative of a follicular adenoma (FA). A thick halo usually corresponds with a thick rim of vessels. An even or uneven thick halo is suspicious for follicular carcinoma. A thick halo, however, is sometimes also seen in adenomas, and a segmented thin halo is sometimes found in nodular goiter. **A** and **B**, Thin, even halo (FA). **C**, Thin, uneven halo (follicular thyroid carcinoma [FTC]). **D**, Thick partial halo (FTC). **E** and **F**, Thick, uneven halo (FTC).

Edge Shadow

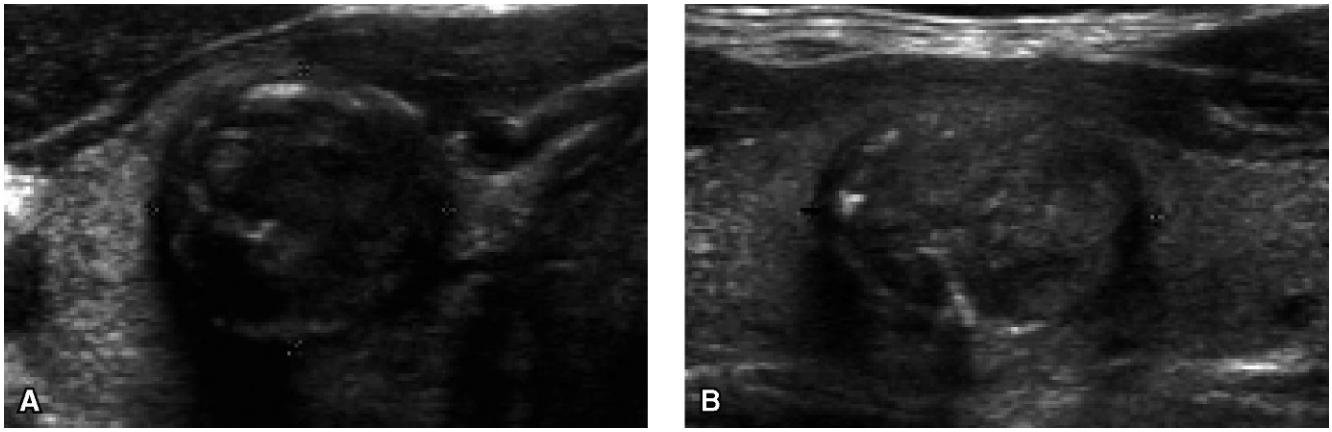

Figure 2–9. Refractive shadows on the side edges of a lesion are probably caused by fibrotic or calcified tissue at the edge of the tumor. Peripheral reactive fibrosis may be prominent in papillary carcinomas [10]. The feature is suspicious for malignancy, but is also seen in benign lesions. This pattern is less prominent in modern ultrasound equipment with cross beam technology. **A**, Colloid nodule. **B**, Papillary thyroid carcinoma.

Infiltration

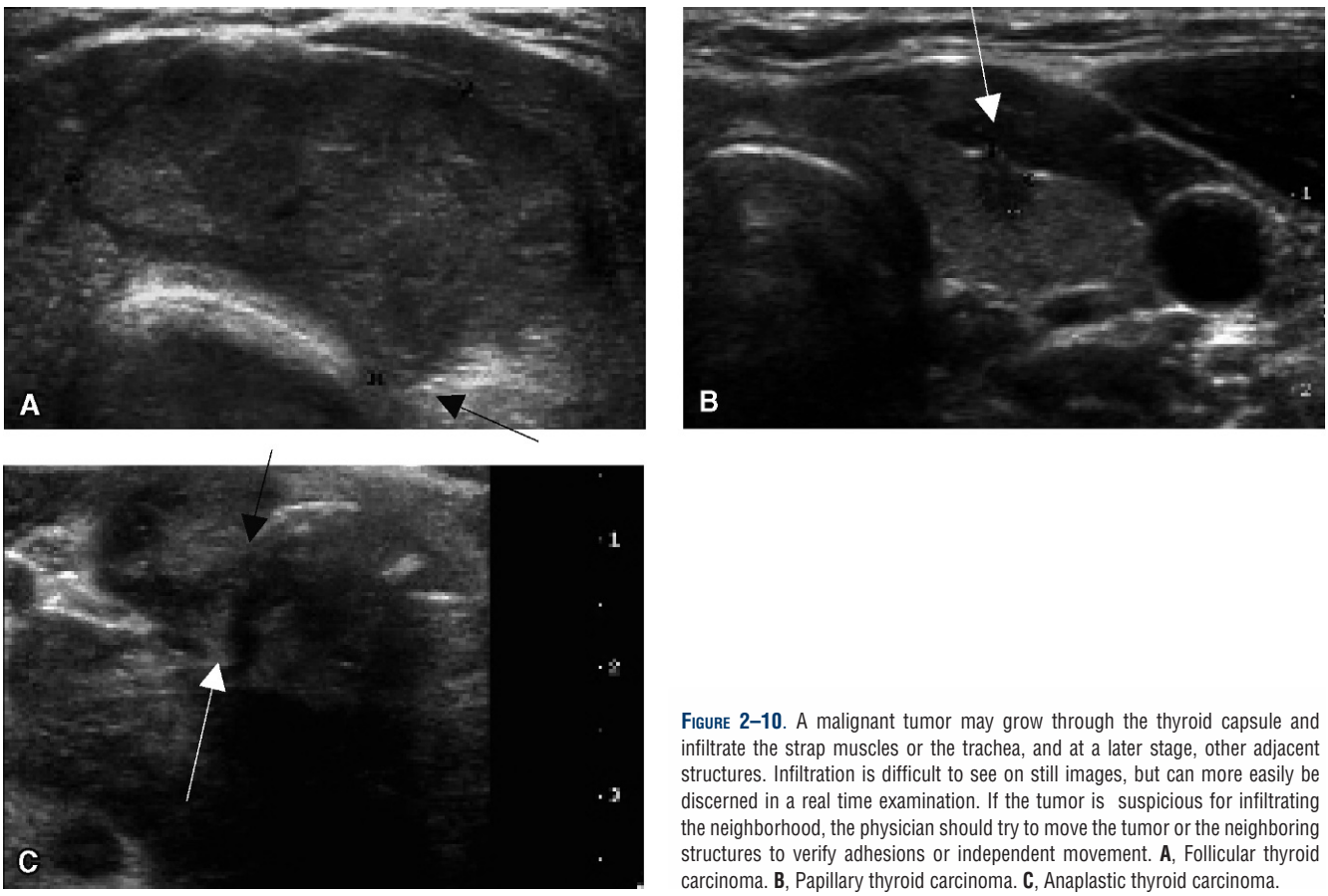

Figure 2–10. A malignant tumor may grow through the thyroid capsule and infiltrate the strap muscles or the trachea, and at a later stage, other adjacent structures. Infiltration is difficult to see on still images, but can more easily be discerned in a real time examination. If the tumor is suspicious for infiltrating the neighborhood, the physician should try to move the tumor or the neighboring structures to verify adhesions or independent movement. **A**, Follicular thyroid carcinoma. **B**, Papillary thyroid carcinoma. **C**, Anaplastic thyroid carcinoma.

Margin

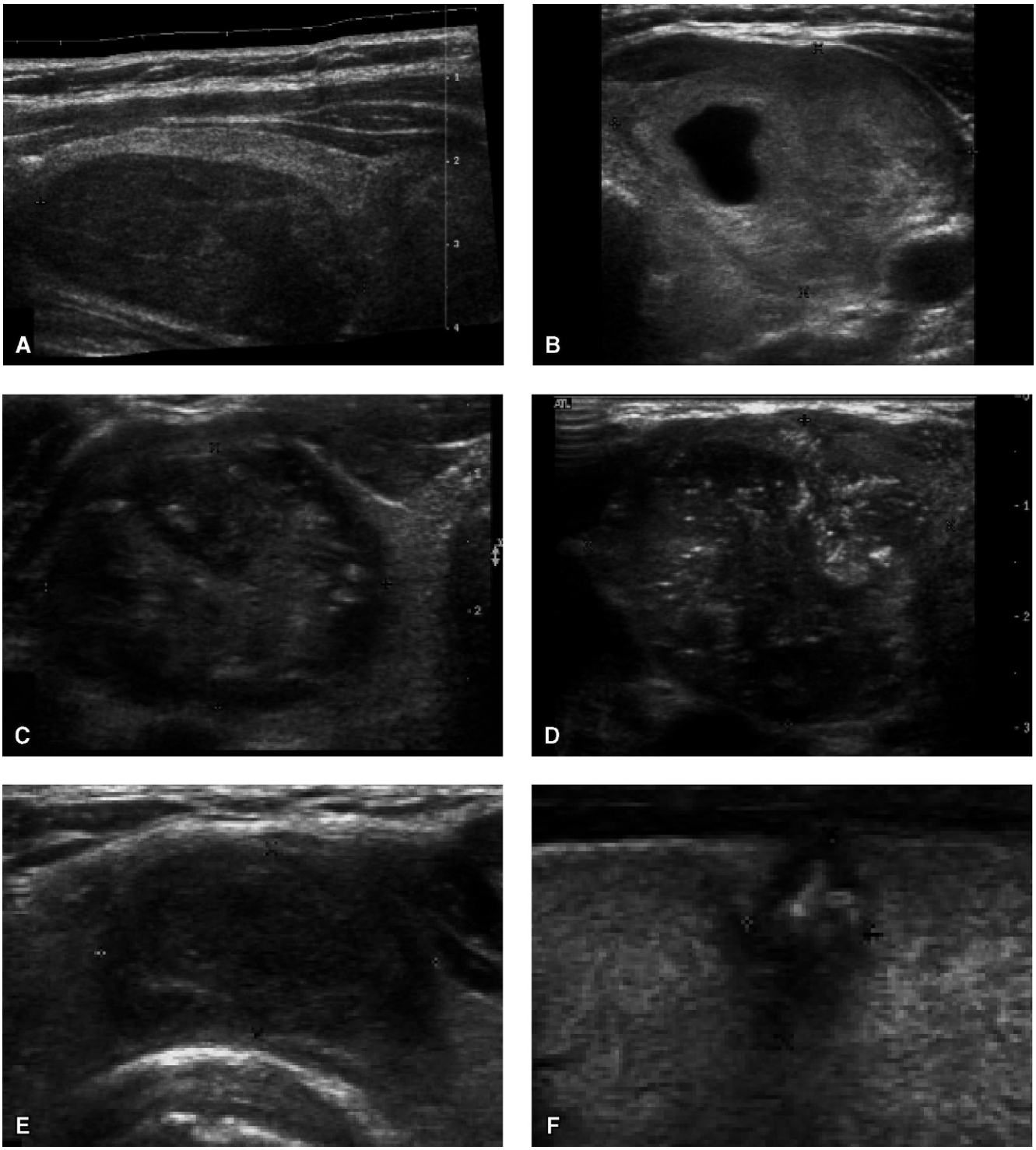

Figure 2–11. The margin of a lesion may be described as well defined or poorly defined, regular or irregular, or the lesion may have a diffuse or blurred margin or be sharply or well circumscribed. A lesion with a well-defined, regular margin is probably benign, and a diffuse or blurred margin is suspicious for malignancy [4,6–10]. **A**, Sharply circumscribed (follicular adenoma). **B**, Well circumscribed (colloid nodule). **C**, Quite well circumscribed (papillary thyroid carcinoma). **D**, Quite well circumscribed (medullary thyroid carcinoma). **E** and **F**, Blurred margin (PTC).

Size and Shape

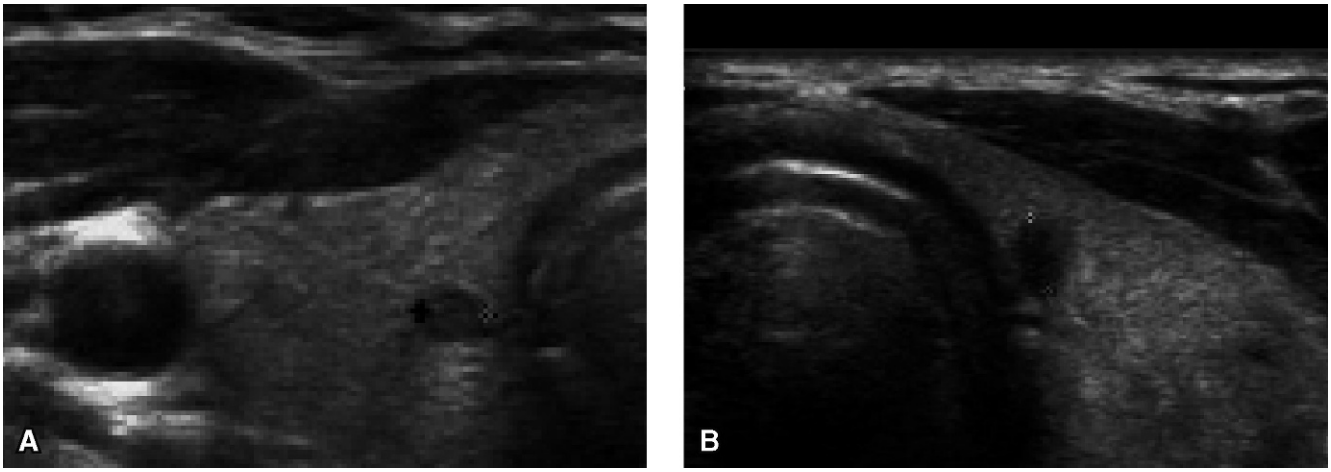

Figure 2–12. A malignant thyroid tumor has no lower size limit. With high resolution ultrasound (US) equipment, papillary carcinomas less than 10 mm in diameter, so-called "microcarcinomas," can also be disclosed [14]. A small, taller than wide nodule, *ie,* with an anteroposterior-to-transverse diameter ≥ 1, is suspicious for malignancy because most benign nodules are wider than tall. However, most malignant tumors also have a taller than wide ratio of less than 1 [8]. Follicular carcinomas often have a diameter of more than 3 cm. Huge, rapidly growing tumors are highly suspicious for anaplastic carcinoma. The description from the US examination has to be precise as to where in the thyroid gland the suspicious lesions are located. This information is of crucial importance, and should be available to the cytopathologist performing the gross examination, and especially in cases where the lesions are small. **A**, Papillary thyroid carcinoma (PTC) 3mm. **B**, PTC 4 mm, taller than wide.

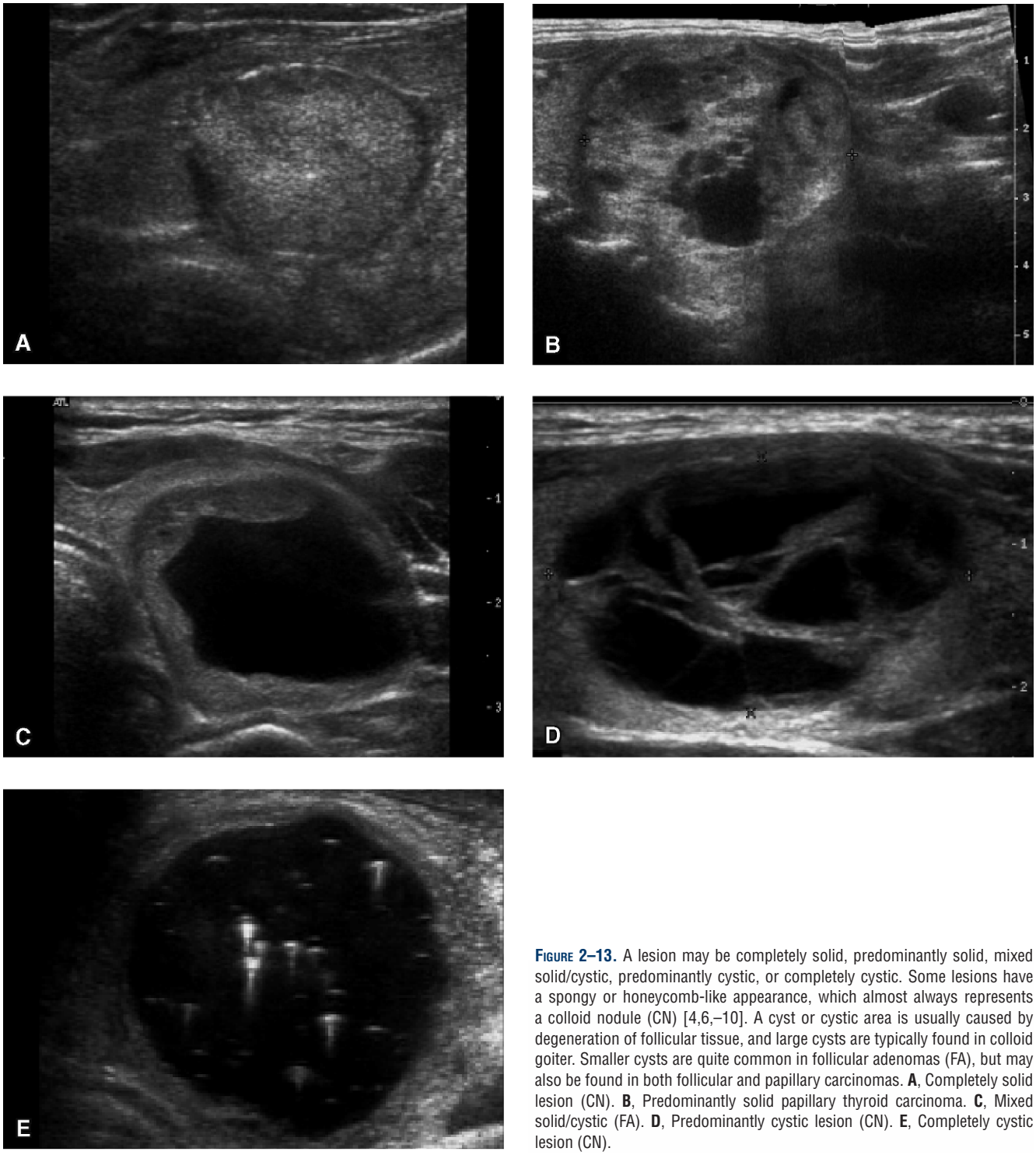

Figure 2–13. A lesion may be completely solid, predominantly solid, mixed solid/cystic, predominantly cystic, or completely cystic. Some lesions have a spongy or honeycomb-like appearance, which almost always represents a colloid nodule (CN) [4,6,–10]. A cyst or cystic area is usually caused by degeneration of follicular tissue, and large cysts are typically found in colloid goiter. Smaller cysts are quite common in follicular adenomas (FA), but may also be found in both follicular and papillary carcinomas. **A**, Completely solid lesion (CN). **B**, Predominantly solid papillary thyroid carcinoma. **C**, Mixed solid/cystic (FA). **D**, Predominantly cystic lesion (CN). **E**, Completely cystic lesion (CN).

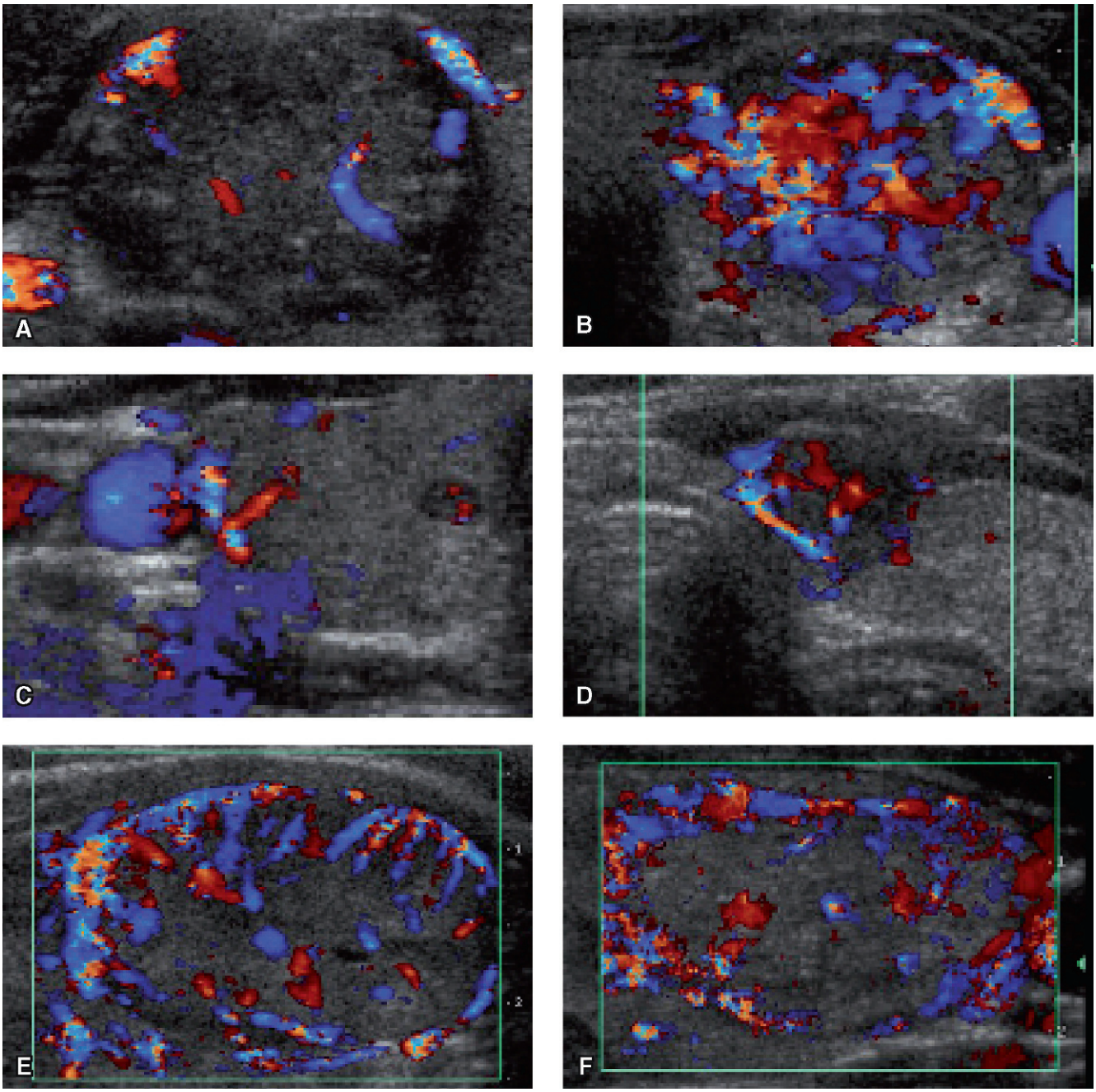

Figure 2–14. Normal thyroid tissue is usually richly vascularized. The different degrees of vascularity in a lesion are difficult to evaluate because both benign and malignant lesions and thyroiditis can present with scant, medium, or hypervascularity. The so-called "thyroid inferno," which means excessive flow, can be found in thyroiditis and in solid tumors. Some authors advocate that papillary carcinomas are almost always hypervascular [6], while other authors have found nonhypervascular papillary carcinomas [15,16]. The latter is also our experience. Other authors have classified vascularity in three groups: type 1 — absence of blood flow; type 2 — perinodular blood flow; type 3 — marked intranodular blood flow [4,7,15]. We believe it is more useful to evaluate the different flow patterns. *Disorganized vascularity,* probably due to neovascularity, is highly suspicious for malignancy [7]. In our opinion visible flow within a very small (3–5 mm) hypoechoic lesion is suspicious for malignancy. Follicular adenomas (FAs) and carcinomas often have a typical flow pattern with a more or less rich flow in the peripheral hypoechoic halo with vessels passing from the periphery toward the central part of the tumor, the so-called *spoke-and-wheel-like vascularity* [6]. In our experience it seems that carcinomas may have richer flow in both the periphery and inside the tumor compared with the flow in the adenomas. **A**, Scantly vascularized papillary thyroid carcinoma (PTC). **B**, Hypervascular PTC. **C**, Three-mm PTC with suspicious vascularity. **D**, PTC with pathologic vascularity. **E**, "Spoke-and-wheel-like" vascularity (FA). **F**, Suggestion of "spoke-and-wheel-like" vascularity (colloid nodule).