Fibroadenoma: From Imaging Evaluation to Treatment

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Background and Epidemiology
Fibroadenoma is the most common benign breast tumor in women younger than age 30. They present most frequently between ages 20 and 50 with peak incidence reported at 20 to 24 years. They account for 68% of all breast masses and a large proportion of breast biopsies.

Fibroadenomas most commonly present as a single, painless, firm, mobile mass, but can be multiple in up to 25% of patients (Figure 1). There is a wide spectrum of associated symptoms, from asymptomatic to extremely painful and cosmetically distorting.

Risk factors for fibroadenoma include age < 35 years, history of benign breast disease, and breast self-examination. The incidence of fibroadenoma has also been shown to directly correlate with body mass index (BMI), with peak incidence seen with BMI 25 to 29.9 kg/m². Increased parity and the use of oral contraceptives appear to decrease fibroadenoma risk.

Pathophysiology and Natural History
Fibroadenomas arise from the lobular stroma of the terminal duct lobular unit. They are a proliferation of epithelial and stromal components, likely related to estrogen. Over time, if left in situ, they undergo hyalinization of the stromal component with regression of the epithelial component.

They are hormone-responsive masses and may undergo cyclic changes in size and symptoms with menses. As such, they increase in size during pregnancy and lactation and are the most common breast tumor diagnosed during pregnancy and the peripartum period. Upon hormone withdrawal during menopause, fibroadenomas commonly involute.

The natural history of fibroadenomas varies from patient to patient with some remaining stable, others demonstrating growth, and others regressing. Most commonly, fibroadenomas decrease in size over time as they lose cellularity. Calcifications can form within the hyalinized or necrotic stroma of involuting fibroadenomas, classically described as coarse, “popcorn-like” calcifications. Malignant transformation of fibroadenomas is rare, occurring in less than 0.3%.

Classic Imaging Features of Fibroadenoma
Mammogram
Fibroadenomas are oval, or less frequently round, equal density masses on mammogram with a circumscribed or obscured margin. Oval fibroadenomas often have lobulations. A dark halo around the mass can be seen due to an optical illusion known as the Mach effect caused by an inbuilt edge enhancement mechanism of the human retina. Calcifications can form within an involuting fibroadenoma and are detectable on mammogram, typically in postmenopausal women. Calcification typically starts at the periphery of the mass and coalesces centrally. Fibroadenoma calcifications can range in morphology from round to coarse dystrophic to pleomorphic (Figure 2B-C). When beginning to calcify, fibroadenomas may appear suspicious, necessitating further imaging evaluation and biopsy. In a postmenopausal patient, when the calcifications are coarse and “popcorn-like,” the diagnosis of involuting fibroadenoma can be made mammographically without further workup. However, a circumscribed mass with calcifications should not be dismissed as an involuting fibroadenoma in a premenopausal woman, as the differential includes cancer. If the morphology of calcifications is suspicious, biopsy may be warranted (Figure 2D). Most often, mammographic features of fibroadenoma are nonspecific requiring further evaluation with ultrasound and possibly biopsy depending on sono- graphic findings.
Fibroadenoma

Contrast-enhanced Digital Mammography (CEDM)

Fibroadenomas may or may not enhance on CEDM. When they do enhance, the level of enhancement is variable. The presence of enhancement may support biopsy, as malignancy typically enhances avidly on CEDM (Figure 3). However, the ultimate decision to biopsy must be based on ultrasound morphology.

Ultrasound

On ultrasound, fibroadenomas typically appear as oval, parallel, circumscribed, uniformly hypoechoic masses with echogenic, thin fibrous internal septations (Figure 1B, 2A) and variable posterior features. Posterior features depend on mass composition, with more hyalinized masses demonstrating posterior acoustic shadowing and epithelial dominant lesions exhibiting posterior enhancement. Associated calcifications can be seen in approximately 10% and are better characterized on mammography. An echogenic rim, or pseudocapsule, surrounding the mass can be seen secondary to compression of adjacent breast stroma. Internal vascularity is seen in up to 80% on Doppler imaging (Figure 1B). When imaging features are not classic (eg, irregular shape or indistinct or microlobulated margins) biopsy should be considered (Figure 4).

MRI

Similar to posterior characteristics on ultrasound, the appearance of a fibroadenoma on MRI varies based on the hyalinization of the mass. Hyalinized or sclerotic fibroadenomas appear T2 hypointense. In contrast, cellular or myxoid fibroadenomas are hyperintense on T2 and hypointense on T1-weighted sequences (Figure 5A-B). Fibroadenomas show variable enhancement patterns. Myxoid fibroadenomas demonstrate rapid homogeneous contrast enhancement whereas sclerotic fibroadenomas show little to no enhancement. Typical fibroadenomas follow type 1 enhancement kinetics: rapid initial and persistent delayed phases (Figure 5C). However, fibroadenomas may have a dynamic contrast enhancement pattern suggestive of malignancy in up to one-third of cases. Classic fibroadenomas will have dark fibrous internal septations (Figure 5D). These nonenhancing septations are seen in 40% to 60% of fibroadenomas. While suggestive of fibroadenoma, these septations are nonspecific and other imaging characteristics and clinical factors must be considered.

FIGURE 1. Multiple fibroadenomas. A 32-year-old woman with multiple fibroadenomas in both breasts. (A) Bilateral CC and MLO views show multiple bilateral similar appearing oval, equal density, partially obscured masses in both breasts (yellow and red arrows), with the largest in the right breast at 12:00, 10 cm from the nipple (red arrows). (B) On ultrasound, the dominant mass at 12:00, 10 cm from the nipple shows typical features of fibroadenoma: a hypoechoic, oval, circumscribed, parallel mass with hyperechoic septations (yellow arrow) and posterior acoustic enhancement.
FIGURE 2. Typical features of fibroadenomas. (A) Hyperechoic septations on ultrasound. (B) Round calcifications on mammogram and ultrasound. (C) Coarse dystrophic (“popcorn”) calcifications on mammogram and ultrasound. However, not all calcifications in a mass are benign. (D) Circumscribed oval mass in a premenopausal woman on baseline mammogram and subsequent ultrasound (top) prompted biopsy with results of fibroadenoma. One year later (bottom), there are new pleomorphic calcifications within the biopsy-proven fibroadenoma prompting re-biopsy, which revealed ductal carcinoma in situ (DCIS). The feature warranting biopsy is the presence of new suspicious morphology (pleomorphic) calcifications.

Differential Considerations and Atypical Imaging Presentations

Variants of fibroadenoma are important to consider, as their management differs slightly from typical fibroadenomas. A juvenile fibroadenoma is a variant seen primarily in adolescence. Apart from patient age, larger size, and characteristic rapid growth (Figure 6), these masses cannot be distinguished from typical fibroadenomas by imaging. At pathology, they are differentiated by the increased stromal hypercellularity of juvenile fibroadenomas. In contrast to typical fibroadenomas, they are usually treated with excision given the rapid growth and larger size.

Another variant is a complex fibroadenoma. While these cannot be completely distinguished from fibroadenoma on imaging, sonographic features suggestive of a complex fibroadenoma include internal heterogeneity, cysts, and punctate echogenic foci. Awareness of these features is important because their presence may motivate biopsy in lieu of routine follow-up. Upon biopsy, complex fibroadenomas may demonstrate cysts, sclerosing adenosis, epithelial calcifications, or papillary apocrine changes. Diagnosis of a complex fibroadenoma has been associated with an increased risk of invasive breast cancer for both breasts. Dupont et al showed that the relative risk of invasive breast cancer is 3.10 times higher for women with complex fibroadenomas compared to 2.17 times higher for patients with typical fibroadenomas. However, a recent study performed by Nassar et al found that complex fibroadenomas do not confer increased risk of breast cancer...
beyond that of the established histologic features and should be managed based on the associated histologic findings.\(^9\)

Another key differentiation is that between fibroadenoma and phyllodes tumor, another fibroepithelial lesion of the breast. In contrast to fibroadenomas, phyllodes tumors, although rare, may have locally aggressive or frankly malignant potential and should be managed surgically.\(^10\) Thus, the differentiation between the two is clinically significant. Fibroadenoma and phyllodes tumor share many common imaging findings and it is difficult to distinguish them on all breast imaging modalities (\textbf{Figure 7A}). The presence of intralvesional clefts and cystic spaces on ultrasound may favor phyllodes tumor (\textbf{Figure 7B}).\(^11\) However, these features have not been found reliably useful for differentiation. A study on MRI differentiation of these lesions found a nonsignificant difference in heterogeneous inner structure and nonenhancing septation, with phyllodes tumors displaying these features more often than biopsy-proven fibroadenomas.\(^7\) In spite of these subtle differences, ultimately the study found that phyllodes tumors and fibroadenomas cannot be precisely differentiated on breast MRI. Diagnosis is further complicated by similar clinical presentation; however,
Phyllodes tumors tend to be diagnosed later in life compared with fibroadenomas, with a median age at presentation of 42 to 45 years. In addition to phyllodes tumors, imaging features of fibroadenoma also overlap with other fibroepithelial lesions including tubular adenoma and lactational adenoma. Tubular adenomas are rare and found primarily in younger women. Tubular adenomas can have varied appearance related to the patient’s age. In younger patients, they appear as a noncalcified, circumscribed, solid mass, similar to a fibroadenoma (Figure 8). In older patients, they can appear as suspicious, irregular masses with microcalcifications requiring core biopsy, although this is less common.

Lactational adenomas are a common solid breast mass diagnosed during pregnancy thought to arise due to the physiologic changes of pregnancy and lactation. Some regard this mass as a variant of fibroadenoma, tubular adenoma, or lobular hyperplasia that has undergone histologic changes as a result of the physiologic state induced by pregnancy (Figure 9). They appear on ultrasound as oval, circumscribed, homogeneous, hypoechoic to isoechoic masses, indistinguishable from fibroadenomas. They may have hyperechoic areas, representing inspissated milk, and posterior enhancement secondary to fluid component, which can serve as useful diagnostic signs on ultrasound. On mammogram, they can have radiolucent areas representing the fat content of the milk secondary to lactational hyperplasia. Rarely, lactational adenomas can appear suspicious on ultrasound with irregular contours and posterior acoustic shadowing. Lactational adenomas require tissue sampling or close surveillance with tissue sampling favored when imaging is atypical; although, there is a small risk for milk fistula after core biopsy.

While it is difficult to distinguish between the different benign fibroepithelial lesions on imaging, it can also be challenging to distinguish between fibroadenomas and malignant masses. Ultrasound features of BRCA-associated breast cancers can resemble a benign mass, such as a fibroadenoma. BRCA-associated breast cancer can appear as a round, circumscribed, hypoechoic and homogenous mass with increased through transmission (Figure 10A-B). Knowing the patient’s personal and family history and BRCA status, if tested, is crucial in determining management of a mass on mammogram, ultrasound, or MRI. What may look like a classic fibroadenoma in an average-risk patient may be a breast cancer in a BRCA-positive or
other high-risk patient (Figure 10C-F).
Thus, biopsy rather than periodic imaging follow-up is more readily performed for benign or probably benign masses in high-risk patients due to their increased lifetime risk of developing breast cancer.

MRI, one of the key screening modalities in the BRCA-positive population owing to its sensitivity, cannot reliably distinguish benign entities from malignancy. For example, fibroadenomas may have a dynamic contrast-enhancement pattern suggestive of malignancy in up to one-third of cases. Additionally, mucinous carcinoma, which is typically T2 hyperintense, often mimics a probably benign lesion. High-grade cancers may have circumscribed margins, a typically benign feature, due to fast cellular growth rates allowing minimal time for the reactive parenchymal changes that contribute to the appearance of a morphologically malignant, spiculated mass.

Breast-specific gamma imaging (BSGI) and its predecessor scintimammography are other modalities used primarily as adjunctive screening tools in high-risk women. When used with mammography for breast cancer screening in women at increased risk and with dense breasts, BSGI significantly improves sensitivity and positive predictive value. BSGI also increases the number of breast cancers detected, as it has been shown to detect mammographically occult breast cancer. BSGI uses the radiotracer Tc-99m sestamibi to identify physiological differences between malignant and normal breast tissue. Focally increased radiotracer uptake is the hallmark of malignancy on BSGI (Figure 11). However, fibroadenomas can present a diagnostic quandary. While generally “cold” on BSGI (Figure 12), fibroadenomas and other benign breast disease can appear “hot”, with increased radiotracer uptake relative to background (Figure 13), similar to other functional modalities, such as MRI and CEDM. In fact, fibroadenomas, fibrocystic disease and inflammatory lesions are regarded as well-known causes of false-positive Tc-99m sestamibi uptake. In these cases, dual-phase imaging in BSGI may help discriminate between benign and malignant lesions based on the assumption that Tc-99m sestamibi uptake by cancerous cells might persist on delayed images compared with benign conditions. A recent study showed that in 11 false positive cases, 9 patients showed tracer washout one hour after tracer injection, supporting this notion.

Treatment Options for Fibroadenoma
If classic features of fibroadenoma are present, the lesion can be followed by imaging every 6 months for 2 years (or at 6, 12 and 24 months) without core biopsy. There is a growing body of evidence showing that periodic imaging surveillance is a safe management option for probable fibroadenomas. A study about long-term follow-up performed
by Gordon et al reported that fibroadenomas may be safely followed with volume growth rates of up to 16% per month for patients < 50 years old and up to 13% per month in those ≥ 50. This study determined that the acceptable mean change in size for all ages was equivalent to a 20% increase in all 3 dimensions in a 6-month period. If > 20% growth is observed during the follow-up period, biopsy should be performed.

Choosing to biopsy a probable fibroadenoma is practice and patient specific. The patient’s personal history, family history, and age are taken into account in conjunction with imaging features of the mass when deciding to biopsy. If any imaging features other than the classic features are present, or if the clinical presentation raises a concern for malignancy or a phyllodes tumor (rapid growth, new presentation after menopause, etc.), a biopsy is recommended. Fibroadenomas with epithelial abnormalities found at core biopsy require surgical excision, even though occurrence of malignancy in or adjacent to a biopsy-proven fibroadenoma is rare.

Fibroadenomas without epithelial abnormality diagnosed by core biopsy need no specific follow-up and can be left alone if asymptomatic. For symptomatic patients wanting definitive treatment for a fibroadenoma, options include surgical excision or minimally invasive techniques, such as ablative procedures and vacuum-assisted core biopsy. Generally, women with fibroadenomas measuring > 3 cm are sent for surgical consultation.

**Surgical Excision**

Surgical excision is the most utilized strategy for definitive treatment of a fibroadenoma. Approximately 500,000 fibroadenomas are treated by surgical excision each year. Surgery is the best option for a symptomatic woman and a consult should be considered. Giant fibroadenomas, also known as juvenile fibroadenomas, require surgical excision due to associated complications including breast distortion, potential for psychological harm, and rapid enlargement that may cause venous congestion, glandular distortion, pressure necrosis and ulceration. While surgery
allows for complete resection, there are risks associated with general anesthesia as well as a greater potential for poor cosmetic outcomes requiring an additional reconstructive surgery. Given the nonmalignant nature of fibroadenomas, an important treatment goal should be cosmesis. A study by Cochrane et al found that the best cosmetic outcomes and highest patient satisfaction occurred when < 10% of the breast volume was excised. Minimally invasive surgical techniques, such as endoscopic lumpectomy, have been pursued for improved cosmesis. In this procedure, 3 small incisions are made in the midaxillary line, a trocar is inserted in the region of the tumor, and carbon dioxide gas is insufflated into the chest wall to facilitate tumor access. The tumor is then dissected and retrieved, either intact or piecemeal depending on initial size, with a specimen retrieval bag. Endoscopic removal by this extramammary approach has been proposed as the best option for benign breast tumors, such as fibroadenomas, considering the young age of the patient population and the excellent cosmetic outcomes. Nevertheless, open excision is still more common. Effort is also made to improve cosmesis in open breast-conserving surgery by making incisions in the circumareolar region or the inframammary crease.

**Minimally Invasive Techniques**

In addition to minimally invasive surgical approaches, minimally invasive office-based procedures have been...
FIGURE 10. Cancer mimicking fibroadenoma. (A,B) A 57-year-old woman with known BRCA gene mutation presented for a palpable right breast mass. (A) Initial ultrasound shows a hypoechoic, parallel mass with circumscribed margins and posterior acoustic enhancement. Subsequent biopsy was performed. (B) Postbiopsy mammogram shows a hyperdense, oval, circumscribed mass containing a coil-shaped biopsy clip. Biopsy results were invasive ductal carcinoma. The patient went on to have a modified radical mastectomy. As seen in this case, BRCA-associated cancers may exhibit benign features, and more liberal biopsy thresholds should be utilized in high-risk patients. (C,D) A 75-year-old woman with a personal history of left breast invasive ductal carcinoma treated with left mastectomy presented with a left chest wall mass. (C) Gray-scale and (D) color Doppler sonography was performed on the area of palpable concern showing a mass, which appears indistinguishable from a benign fibroadenoma on imaging alone. However, given the patient history, this mass is suspicious. Biopsy was performed revealing invasive ductal carcinoma. (E,F) A 66-year-old woman with a remote personal history of right breast cancer treated with breast conservation therapy presented for an annual screening mammogram. (E) The mammogram shows an oval, partially obscured right breast mass. (F) Gray-scale (top) and power Doppler (bottom) images from targeted ultrasound show a solid, oval, circumscribed, homogeneous, hypoechoic mass. The mass was biopsied with results of papillary carcinoma.
used in treating fibroadenoma. Office-based techniques performed under local anesthesia lack the risks of general anesthesia and are relatively painless compared to open surgery. They also promise improved cosmetic outcomes, with little to no tissue loss during percutaneous ablative techniques. Office-based procedures are also more cost effective. Surgical techniques, however, have the advantage of allowing for additional pathologic analysis upon removal.

**Vacuum-Assisted Breast Biopsy**—Small (< 2 to 3 cm) fibroadenomas can be removed under image guidance using a vacuum-assisted device, similar to that used for vacuum-assisted core needle biopsy. Multiple samples are obtained with the needle until the mass appears completely removed. Complete excision is not guaranteed and hemorrhage and hematoma can result due to the multiple samples required for removal, especially when fibroadenomas are > 2 cm.

Hematoma formation occurs at a rate of 0% to 13%. Removal of the lesion ranges from 22% to 98% depending on the quality of imaging technique, needle gauge, and initial size of the lesion. This technique is not utilized for malignant lesions due to the risk of incomplete removal. Despite incomplete removal and resulting risk of recurrence, patients report high satisfaction with the procedure and prefer it to surgical excision. The American Society of Breast Surgeons (ASBrS) endorses ultrasound-guided percutaneous excision of fibroadenomas in their 2008 statement as a safe, effective and well-tolerated procedure with minimal cost, low morbidity, and desirable cosmetic outcomes.

**Percutaneous Ultrasound-Guided Cryoablation**—Percutaneous cryoablation is an FDA-approved nonsurgical option for patients desiring definitive, minimally invasive treatment of a fibroadenoma. Cryoablation is also endorsed by the ASBrS in their 2008 statement as a safe and efficacious treatment for fibroadenoma. Careful patient selection is made using ASBrS criteria for cryoablation of fibroadenoma including the need for visibility by ultrasound, definitive histologic confirmation with core biopsy, and size < 4 cm. Although it is a well-accepted treatment option in the medical community, cryoablation is not widely utilized as many insurance companies categorize it as investigational.

Cryoablation systems use a cooling gas under pressure inside a shielded probe to freeze adjacent tissue. Real gases change temperature relative to pressure when forced through a valve and heat exchange with the environment is prevented. This principle is known as the Joule-Thomson Effect, or throttling process, and is the basis for cryoablation systems. The amount and direction of temperature change depends on the Joule-Thomson coefficient of a gas, which represents the

**FIGURE 11.** Cancer mimicking fibroadenoma with breast-specific gamma imaging (BSGI) correlation. A 34-year-old woman with a family history of breast cancer in her mother and grandmother presented for a palpable left breast lump. (A) Ultrasound shows a microlobulated, hypoechoic mass with irregular margins at the 1:00 position (yellow arrow). (B) A subsequent BSGI study shows increased isotope uptake correlating to the 1:00 position palpable mass (yellow arrows). Subsequent biopsy revealed fibroadenoma. (C) Postultrasound-guided biopsy mammogram shows a biopsy clip in the region of increased isotope uptake (yellow arrows). Biopsy results were considered discordant based on ultrasound and BSGI imaging findings. The patient went on to have an excisional biopsy with results of invasive ductal carcinoma.
rate of temperature change relative to pressure. Nitrogen or argon gas is used most commonly in cryoablation systems based on their favorable coefficients.

During the procedure, a 9- or 10-gauge cryoablation probe is inserted into the center of the breast tumor under real-time sonographic guidance after administration of local anesthesia. High-pressure gas is forced through the center chamber of the dual-chambered probe. At the tip of the probe, the gas enters the expansion chamber where pressure decreases and the gas cools. The cold gas absorbs heat energy from the surrounding tissue via conduction, lowering tissue temperature and freezing the adjacent tissue, creating an “ice ball” (Figure 14). Tissue temperature is coldest adjacent to the probe, reaching -140°C to -160°C, and increases as distance from the probe increases. The visible rim of the ice ball represents the 0°C isotherm, which is not tissue lethal. The lethal isotherm is not visible. It is typically located at least 5 mm central to the outer edge, with lethal temperatures -20°C to -40°C depending on tissue type. For effective treatment, the lethal zone must cover the entire target lesion with at least a 5-mm ablation margin. The diameter of the “ice ball” is determined by the flow of gas and the length of the “ice ball” is determined by uninsulated probe length. If necessary, multiple probes can be utilized to increase the lethal zone. Precaution must be taken to ensure that the “ice ball” does not extend to involve other structures. One trial for cryoablation of breast cancer required that the mass was >5 mm deep to the skin and nipple. However, in practice, there is no official criteria defining an acceptable distance from other structures. Techniques, such as injecting saline to create a buffer between the mass/treatment area and skin, can help prevent unintended damage.

The cryoablation procedure consists of a freeze-thaw-freeze cycle and

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**FIGURE 12.** Typical fibroadenoma features on breast-specific gamma imaging (BSGI). (A) A 39-year-old woman presented for a screening mammogram, which shows a 1.6 cm oval, circumscribed mass at the 3:00 position (yellow arrow). (B) On subsequent diagnostic ultrasound, this correlates with a 1.6 cm oval, hypoechoic mass with circumscribed margins. (C) Subsequent BSGI study shows no abnormal isotope uptake, supporting the mammographic and sonographic features of a fibroadenoma, which was categorized as a BIRADS 2.
can take up to 25 minutes depending on tumor size. This cycle destroys tumor cells through direct cell damage and death, vascular injury and ischemia, and indirect immunologic mechanisms.\textsuperscript{25} During freezing, there is formation of intracellular, extracellular, and intravascular ice. Intracellular ice causes pore formation in the cell wall. Extracellular ice decreases extracellular free water and increases extracellular osmolarity. As a result, water exits the intracellular compartment causing cell shrinkage and dehydration.

During thawing, extracellular ice melts before intracellular ice causing increased free extracellular water. Endothelial damage caused by intravascular ice increases vascular permeability and contributes to increased extracellular water and decreased extracellular osmolarity. Osmotic gradients force water inside cells during thawing, causing cells to swell and burst leading to cell damage and death.\textsuperscript{25} Delayed immune response then leads to absorption of damaged tissue, taking up to one year for the fibroadenoma and treatment zone to become nonpalpable. There is no routine follow-up imaging required for patients after cryoablation of fibroadenoma. Patients are followed clinically with a focus on palpability of the fibroadenoma and treatment zone.

Multiple studies have assessed outcomes of cryoablation for fibroadenomas. For example, Littrup et al found that 89% of all fibroadenomas, independent of original size were nonpalpable at 12 months.\textsuperscript{26} Kaufman et al in 2004 found that 75% of all fibroadenomas were nonpalpable at one year with a 92% patient satisfaction rate.\textsuperscript{27} In 2005, Kaufman et al demonstrated that 84% of previously palpable fibroadenomas and 94% of fibroadenomas ≤ 2 cm were nonpalpable at an average follow-up time of 2.6 years with a 97% patient satisfaction rate.\textsuperscript{28} They also showed a 99% median volume reduction of treatment zone by ultrasound in that
follow-up interval. Hahn et al showed that the average volume of the ablation zone was reduced by 75% at the one-year mark with a patient satisfaction rate of 96%. Another study by Golatta et al assesses outcomes of cryoablation in fibroadenomas <3 cm and found that 93% were nonpalpable at one year with a patient satisfaction rate of 97%. Reported adverse events in these studies were minor, including localized skin changes, induration, hematoma, and continued breast pain.

Radiofrequency Ablation (RFA) — RFA utilizes a high-frequency alternating electric current administered via a probe centered in the target lesion, similar to cryoablation. The electric current heats adjacent tissue water molecules causing coagulation. Water molecules are more prevalent in neoplastic tissue compared to healthy surrounding tissue. Furthermore, neoplastic vessels are abnormal and more susceptible to the coagulative effects as compared to healthy vasculature. These characteristics combine to cause preferential ablation of abnormal tissue. In RFA, a 1-cm margin of tissue is required around the lesion, limiting its use for lesions near the skin, chest wall, or breast implants. Most literature regarding RFA centers around breast carcinoma and many consider it the most promising ablation modality for breast cancer with good long-term outcomes. Studies investigating RFA for fibroadenoma are limited. However, small studies have shown success. Teh et al reported on RFA treatment of 2 patients with fibroadenoma, both of whom had complete clinical and technical success at 6-month follow-up. Further investigation to better delineate the role of RFA in fibroadenoma treatment is required.

Laser Ablation — In laser ablation a thin fiber is inserted percutaneously under either ultrasound or MRI guidance. Low-power laser light energy is delivered via the fiber, which heats the surrounding tissues. Tumor necrosis depends on exposure time and tissue temperature. Tissue temperatures can be followed by MR thermometry or with internal temperature monitors. The area and shape of the necrosis is difficult to predict due to biologic variability, fiber tip charring, and changing optical and thermal properties of the tissue during laser photocoagulation. Only a few studies have used this technique for fibroadenoma treatment. While this technique boasts quick treatment times and success rates comparable to fibroadenoma cryoablation in the few studies performed, there were more frequent complications, notably skin breakdown and pain. As a result, it is not widely implemented in clinical practice.

High-Intensity Focused Ultrasoundography (HIFU) — This is a relatively new, completely noninvasive ablative technique in which an ultrasound beam generated by a piezoelectric transducer is focused on the target tissue under either MRI guidance (MRgFUS) or ultrasound guidance. The ultrasound beam propagates through tissue as a high-energy pressure wave that heats target tissue to 60-95°C causing protein denaturation and coagulative necrosis without impacting surrounding healthy tissue. This technique has shown success in breast cancer treatment, and phase II clinical trials are ongoing. HIFU is also being investigated as a treatment for fibroadenoma. Hynnen et al treated 11 fibroadenomas with MRgFUS and had technical success of 72%, defined as partial or complete nonenhancement on follow-up MRI. An additional study by Kovatcheva et al showed a volume reduction of 72.5% at a 12-month follow-up. Other studies are ongoing with further patient.

FIGURE 14. Fibroadenoma cryoablation. Percutaneous ultrasound-guided cryoablation was performed for a biopsy-proven fibroadenoma < 4 cm and visible by ultrasound. (A) A sonographic image taken during the procedure shows the cryoablation probe (red arrow) centered in the fibroadenoma. (B) A subsequent intraprocedural image shows the “ice ball” formed after the freeze-thaw-freeze cycle (blue arrow indicates the edge of the ice ball, the 0 °C isotherm).
follow-up required. While promising, more research into applications of this technique for fibroadenoma is necessary.

Conclusion

Fibroadenomas are common breast masses, especially in women under age 30. The imaging features of fibroadenoma overlap with multiple other benign and malignant breast masses. As such, fibroadenomas account for a large proportion of breast biopsies. Cosmesis is a central concern when treating fibroadenomas given the benignity and patient population. Open surgical excision remains the most common treatment choice. However, multiple minimally invasive techniques, notably ultrasound-guided percutaneous cryoablation, have been utilized to effectively treat fibroadenoma with improved cosmetic outcomes as well as other advantages including cost-effectiveness, lack of general anesthesia risks, and increased patient comfort.

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