MRI-Guided Vacuum-Assisted Breast Biopsy with a Handheld Portable Biopsy System

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OBJECTIVE. The purpose of this study was to evaluate a compact portable 10-gauge handheld battery-operated vacuum-assisted biopsy system for MRI-guided breast biopsy.

CONCLUSION. The compact portable battery-operated biopsy system can be used successfully for MRI-guided core breast biopsy and is an alternative to current systems.

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Breast MRI is gaining widespread acceptance as an adjunct to mammography and sonography in the detection and diagnosis of malignancy. Although breast MRI has sensitivity approaching 100% for invasive carcinoma, specificity as low as 37% has been reported [1], providing a challenge in the management of suspicious lesions detected with MRI alone. For patients with these lesions, minimally invasive percutaneous core needle biopsy is favored over wire localization with subsequent surgical biopsy to avoid the risks, morbidity, and excessive costs associated with open surgical biopsy. Until recently, percutaneous biopsy has been difficult because of the limited availability of MRI-compatible needles and MRI biopsy equipment and the expense of the biopsy systems. Several studies, however, have shown promising results with fine-needle aspiration [2], conventional automated core needles [3], and vacuum-assisted biopsy systems [4–6]. We describe a new method of performing MRI-guided vacuum-assisted biopsy with a 10-gauge handheld compact mobile biopsy system (Vacora Vacuum Assisted Biopsy System, Bard Biopsy Systems).

Materials and Methods
Institutional review board approval was obtained, and informed consent was waived for this retrospective study. All patients who underwent MRI-guided biopsy between January 1, 2004, and November 30, 2004, were identified by review of Current Procedural Terminology billing records. MRI-guided biopsy performed on 19 patients yielded 20 lesions that were occult according to mammographic and sonographic findings but were identified on contrast-enhanced breast MRI as necessitating either high-risk screening or staging of the breasts in patients with known carcinoma. Second-look sonography was performed for all lesions seen with MRI, and MRI-guided biopsy was performed only on the sonographically occult lesions.

All lesions were sampled with a novel self-contained handheld vacuum-assisted biopsy system. With this system, a disposable 10-gauge biopsy needle is attached to an integrated vacuum syringe that fits into a reusable small handheld housing unit (Fig. 1). The device applies suction to the tissue at

Fig. 1—Photograph shows vacuum-assisted biopsy system with 10-gauge biopsy needle attached to integrated vacuum syringe contained within handheld housing unit. (Courtesy of Bard Biopsy Systems, Tempe, Arizona)
the cutting well of the needle by automatically withdrawing the plunger of the vacuum syringe. Power for the system is provided by a rechargeable lithium-ion battery. The device is controlled with an integrated touch pad with three buttons for positioning, firing, and sampling the lesion.

When the procedures were performed, written informed consent had been obtained after risks and benefits were explained to the patient. All imaging was performed with a conventional 1.5-T MR scanner (Signa, GE Healthcare). Each procedure was performed with the patient in a prone position, and a dedicated surface coil was used (Liberty 5000, USA Instruments). The affected breast was stabilized with moderate compression from a lateral fenestrated grid. Three fiducial markers were placed around the expected site of the lesion, and localizing sequences were acquired. Gadopentetate dimeglumine (Magnevist, Berlex) 0.1 mmol/L per kilogram of body weight was administered rapidly through an existing peripheral IV catheter, and sagittal T1-weighted fat-suppressed gradient-recalled echo sequences (TR/TE, 17/2.0; field of view, 16–18 cm; slice thickness, 1–2 mm; matrix, 512 × 512; no gap) were acquired. Images were reviewed on the monitor, and a cursor was placed at the site of the lesion. Horizontal (z-axis) and vertical (y-axis) coordinates were determined by measurement of the distance from the fiducial marker to the lesion. Depth (z-axis) was determined by calculation of the number of sagittal slices from the grid to the lesion. One centimeter was added to the depth calculation to account for the thickness of the fenestrated grid.

The MRI table and patient were withdrawn from the magnet, and the location of the lesion was established on the grid. The skin was anesthetized, and a small skin incision was made with a number 11 surgical blade. An MRI-compatible coaxial needle consisting of an outer plastic sheath and an inner titanium stylet (Vacora, Bard) was advanced, and the tip of the sheath was placed approximately 1 cm lateral to lesion center. The inner stylet was removed, and localizing sequences (TR/TE, 17/2.0; field of view, 16–18 cm; slice thickness, 1–2 mm; matrix, 512 × 512; no gap) were acquired. Images were reviewed on the monitor, and a cursor was placed at the site of the lesion. Horizontal (z-axis) and vertical (y-axis) coordinates were determined by measurement of the distance from the fiducial marker to the lesion. Depth (z-axis) was determined by calculation of the number of sagittal slices from the grid to the lesion. One centimeter was added to the depth calculation to account for the thickness of the fenestrated grid.

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After tissue acquisition was complete, the biopsy device was removed and an MRI-compatible marker clip (Artemis Medical) was deployed through the plastic sheath. Postprocedure sagittal T1-weighted imaging was performed to document adequate sampling of the lesion, to document marker placement, and to determine the presence of postprocedure hematoma. Imaging–histologic correlation was performed for all biopsy results to determine concordance. A 6-month follow-up MRI examination was recommended for all concordant benign lesions, and surgical excision was recommended for all malignant, discordant benign, or high-risk lesions.

Results

Nineteen patients (age range, 37–76 years; mean age, 53.6 years) with 20 lesions underwent MRI-guided vacuum-assisted biopsy with successful microclip placement in all cases. The biopsy was considered successful if postprocedure imaging showed partial or complete removal of the lesion at the site of the biopsy cavity. Postprocedure imaging showed complete removal of one lesion and partial removal of 13 lesions. In five cases, postprocedure assessment was impaired by the presence of a small (< 1 cm; n = 2) or moderate-sized (1–3 cm; n = 3) hematoma that obscured the lesion. All five lesions were considered successfully sampled after imaging–histologic concordance was determined.

An unsuccessful attempt was made to sample one lesion that was posterior to the biopsy compression grid by application of suction and posterior sampling. Postprocedure imaging showed the biopsy cavity anterior to the lesion, indicating inadequate sampling, and surgical excision was recommended.

The 19 successfully sampled lesions (size range, 4–20 mm; mean size, 8 mm) resulted in one invasive ductal carcinoma (Fig. 2), four high-risk lesions (two atypical ductal hyperplasia, one lobular carcinoma in situ, one papilloma with atypia with adjacent radial scar), and 14 benign lesions, including one fibroadenoma, three areas of fibrosis, two areas of fibrocystic change, one area of fat necrosis and fibrocystic change, one area with sclerosing adenosis, one hemangiomata, one benign lymph node, and four areas of benign breast tissue. The papilloma and radial scrap were present in the same biopsy.

Invasive ductal carcinoma was confirmed surgically for the one malignant lesion. One case of atypical ductal hyperplasia was upgraded to invasive ductal carcinoma and ductal carcinoma in situ. The findings in the other case of atypical ductal hyperplasia, the case of lobular carcinoma in situ, and the radial scar were unchanged. After surgical excision the papilloma with atypia was downgraded to papilloma with benign florid epithelial hyperplasia.

All 14 of the benign lesions were determined to be concordant with imaging characteristics, and 6-month follow-up MRI was recommended for stability. Fourteen percent (2/14) of the benign biopsy findings were confirmed at surgery in patients who chose mastectomy for ipsilateral malignant lesions. Twenty-nine percent (4/14) of the lesions were examined with follow-up MRI 4–8 months after biopsy. The images showed resolution of the lesion in three cases and decreased size of the lesion in one case. Although mammographic follow-up was not recommended for these lesions because the lesions were occult to mammography, 21% (3/14) of the lesions had negative results on follow-up mammography but were not imaged with follow-up MRI. In the case of 7% (1/14) of the lesions, the patient was receiving neoadjuvant therapy for known breast cancer in the ipsilateral breast and had not yet undergone follow-up breast imaging. The patients who underwent 29% (4/14) of the biopsies were lost to follow-up.

Discussion

MRI-guided vacuum-assisted biopsy has been performed successfully for a number of years in Europe and more recently in the United States with success rates ranging from 94–98% [4–6]. The diagnostic accuracy of this technique approaches that of MRI-guided needle localization with subsequent surgical excision [7].

Advantages of MRI-guided vacuum-assisted core biopsy include lower risk, morbidity, and expense compared with surgical biopsy; greater accuracy than fine-needle aspiration [2]; and larger volume of tissue sampled compared with automated core needle biopsy [3], resulting in lower sampling error. The Vacora vacuum-assisted biopsy system has a compact frame, and the lightweight mechanical housing is easy to hold and maneuver during procedures. Although multiple insertions are necessary to retrieve tissue, the stylet can be easily slipped through the coaxial sheath for rapid tissue retrieval. The battery-operated needle system with an attached integrated vacuum cylinder is independent of bulky wires, cables, and cumbersome vacuum carts and therefore is easy to store and carry in and out of the MRI room.

Our success rate of 95% falls within the 94–98% range reported for other MRI-guided vacuum-assisted systems confirmed with surgical histologic examination [4–6]. Our rate of positive biopsy findings (5% malignant, 21% atypia, 74% benign) included a larger number of false-positive results than previously reported [4–6], probably because of our small sample size.
Limitations of the technique parallel those described for stereotactic biopsy and MRI biopsy in previous studies, including difficulty of accessing lesions in a thinly compressed breast [7, 8] and lesions located far posteriorly within the breast [8]. In two patients with thin breasts and medially located lesions, vacuum-assisted biopsy resulted in minimal piercing of the skin in the medial aspect (the side opposite the skin entry site) that produced temporary discomfort for the patient. Decreasing the amount of compression [8], injecting a generous amount of local anesthetic medial to the lesion [7], and accurately measuring the depth of the lesion with respect to the thickness of the breast may help to avoid this problem in the future.

Posterior lesions pose challenges for all core biopsies, as previously described for prone stereotactic biopsy [8], because of the difficulty of capturing the lesion in the fenestations.

Fig. 2—37-year-old woman with history of right breast lumpectomy for invasive ductal carcinoma. Suspicious spiculated mass was found at MRI examination.
A, Sagittal T1-weighted contrast-enhanced image shows irregular, rapidly enhancing mass (arrow).
B, Axial T1-weighted contrast-enhanced image shows needle tip positioned just lateral to irregular mass (arrow). Patient is prone and only small portion of breast was scanned to visualize needle and lesion in central and slightly lateral breast. Thus, nipple and axilla are not included on margins of film.
C, Postprocedure sagittal T1-weighted contrast-enhanced image shows air at biopsy site with partial removal of lesion (arrow) and biopsy marker clip in place. Pathologic findings confirmed invasive ductal carcinoma.
Liberman et al. [6] found that tissue adjacent to the needle can be acquired with vacuum-assisted biopsy if needle placement is close to but not exactly at the site of the lesion. This modification is potentially useful for accessing lesions located just posterior to the fenestrated grid; however, we were unsuccessful in our attempt to perform biopsy on a lesion posterior to the grid.

In conclusion, the Vacora core needle biopsy system is a vacuum-assisted device that can be successfully used for MRI-guided core breast biopsy. In our experience, this portable handheld battery-operated device is a versatile alternative to other vacuum-assisted systems.

References