

Electronic Integrated Diagnostic Report for Presenting Results of Breast Imaging and Breast Biopsy

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Abstract: Most breast imaging practices have an organized system for reviewing the results of breast biopsies, assessing radiologic-histologic concordance, and making follow-up management recommendations. Yet, historically, the breast pathology report and radiologic addendum have been separated within the electronic medical record. Having the two entities fused into one integrated diagnostic report (IDR) has provided both a concise summary of the pertinent findings of imaging and histologic examinations related to the patient's care and clear guidance for treatment and follow-up. Direct correlation between imaging and histologic findings has been shown to decrease discordance between these findings and increase diagnostic accuracy. The IDR is also a useful summary for conferences of tumor boards and multidisciplinary clinics. In addition, the software that is used for generating the IDR is capable of identifying patients who may benefit from clinical trials.

Keywords: *integrated diagnostic report, radiologic-histologic correlation, concordance*

Discussion

The development of the integrated diagnostic report (IDR) involved a coordinated effort of the department of radiology (including both radiologists and software designers) and the department of pathology. Given that the development of the IDR promised to reduce radiologic-histologic discordance or potential misdiagnoses, it was thought that this development would be a worthwhile endeavor.^{1,2,3} The Breast-IDR is built on the integrated diagnostic (IDx) platform that uses the Java-based Grails web application framework to identify and integrate clinical data and to structure the report. As in the IDRs developed for integrating radiologic and histologic clinical data with reports for diagnosis of lung cancer and targeted prostate

biopsy,^{4,5} the data feed in the Breast-IDR comes from three sources: the laboratory information system, the picture archiving and communication system (PACS), and the active directory with a single sign-on server. In addition, the Breast-IDR incorporates mammography reporting and tracking software (MagView; Applied Software Inc) and breast imaging viewing system (SecurView; Hologic Inc) synchronized with PACS and the sign-on server.

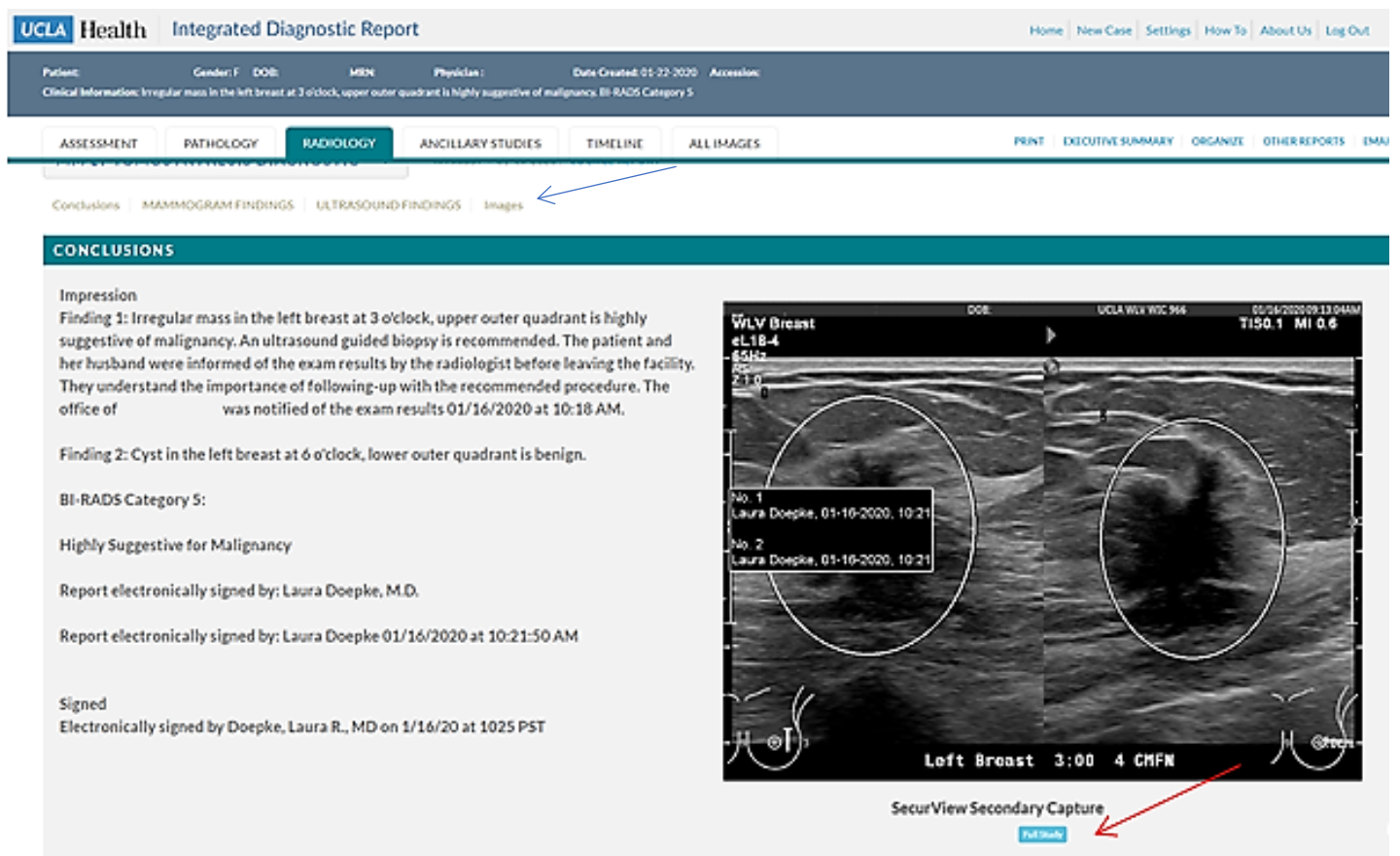
The generation of a specific report on Breast-IDR begins at the time of a medical work-up. When a patient is seen for a diagnostic mammogram and/or ultrasound, the pertinent finding (eg, mass, calcifications, architectural distortion) that is recommended for biopsy is circled on diagnostic images within SecurView. Once the study is marked as read, the annotated images are sent to

PACS and saved as significant images. These images will then be identified and integrated into a final report on the Breast-IDR (Figure 1). The completion of a biopsy and reviews of the results of imaging and histologic examinations triggers the generation of the Breast-IDR. At this time, all relevant images and examination reports are integrated into the IDR (Figures 1, 2, 3). In some instances, a finding on a screening

examination is indeterminate and can lead to additional work-up. However, given that most “callback findings” prove to be benign and are not biopsied, screening findings are omitted from the IDR.

Once the results of histologic examination become available, a standardized addendum to the biopsy report is issued in Magview according to the options available in the pull-down menus. In the

Figure 1. Breast-IDR Radiology Page Showing Significant Images



The blue “Full Study” button (red arrow) provides access to all images of the biopsy. The “Images” button (blue arrow) provides access to all radiologic studies performed on the patient.

addendum, the radiologist not only enters the histologic diagnosis from the options available in the digital library, but also, and more importantly, addresses whether the results are concordant with the imaging findings and makes a clear recommendation for follow-up. Once the standardized addendum is issued within MagView, the integrated radiology-pathology report is finalized automatically with creation of hyperlinks

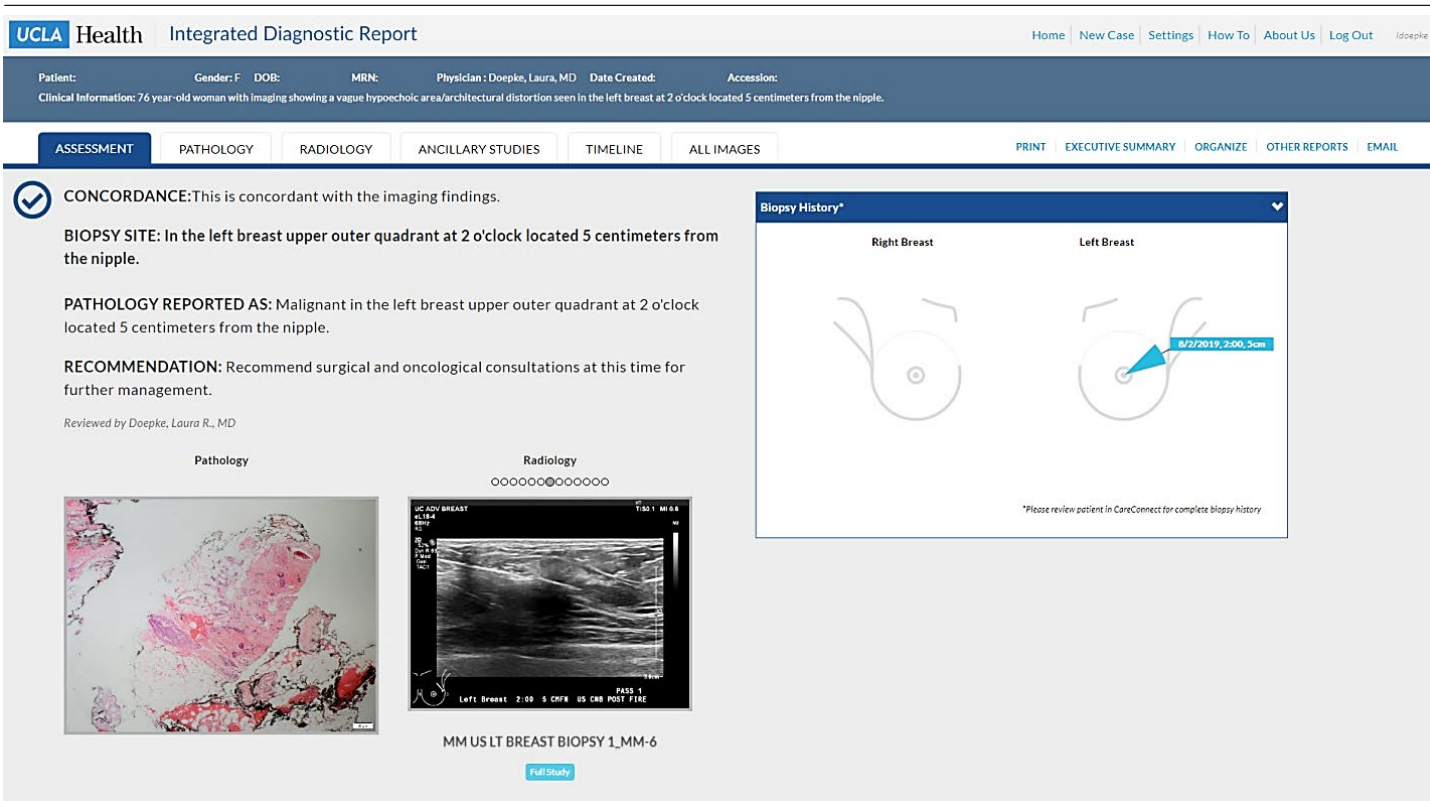
from the source reports to the Breast-IDR case. For patients with a diagnosis of breast cancer based on the results of a core needle biopsy, the specific biomarkers are also added. Because the report is generated prior to the completion of fluorescence in situ hybridization (FISH) testing, the preliminary ERBB2 (formerly HER2/*neu*) gene status is entered as follows: Positive 3+, Equivocal 2+, Negative 1+ or 0. After the FISH report is

issued and the final ERBB2 gene status is complete, the data are automatically uploaded into the Breast-IDR (Figure 4).

The Assessment page of the Breast-IDR displays a "Biopsy History" diagram of the breasts with hyperlink labels indicating the sites of the breasts that have been biopsied (Figure 5). The "Additional Findings" section (Figure 6) on the Assessment page of the Breast-IDR provides

recommendations for patients who may need follow-up (the source report BI-RADS Category 3 recommendations for management of other findings that were not biopsied). Furthermore, the section hyperlink provides access to the diagnostic report with additional findings that require follow-up (Figure 7). Finally, a "Timeline" tab on the Breast-IDR user interface provides access to the summary of all imaging (including cross-sectional

Figure 2. Breast-IDR Assessment Page Showing Images of an Ultrasound-guided Breast Biopsy.



Note the prominent concordance assessment.

imaging) and pathology examinations that a patient underwent in David Geffen School of Medicine at UCLA. The blue "View Imaging" button (Figure 8) on the "Timeline" page provides direct access to any prior imaging examination of a particular patient. This function is useful in clinical settings where maintaining patient privacy is important while showing patients their imaging studies; it allows opening the images without accessing PACS and exposing other patients' information on the screen. In addition, the "view imaging" button is exceptionally useful for conferences of tumor boards and specialty

clinics^{6,7} when quick access to imaging is highly desirable.

The Breast-IDR has shown to be a useful tool in research and data mining.⁷ Subsequent to its creation, in a recent clinical trial that evaluated response to neoadjuvant chemotherapy in patients with triple negative breast cancer, the Breast-IDR has been tested for its capacity to identify patients with newly diagnosed breast cancer and specific tumor subtypes. The Breast-IDR completed this test quickly and accurately. This is of great value to patients who may benefit from new therapies. In addition to research and

therapeutic applications, the Breast-IDR can be helpful for improving practice patterns of physicians. The development of a dashboard that will catalog all biopsy recommendations made by each radiologist is underway. This will provide a concise summary of both the imaging that led to a biopsy and the biopsy results. The purpose of this dashboard is to educate radiologists on the positive predictive value of their biopsy recommendations with the goal to improve practice patterns and reduce unnecessary biopsies.

Conclusion

In summary, the Breast-IDR is useful to referring doctors, radiologists, and pathologists in accessing diverse information with sufficient granularity for better decision-making. It is a valuable medium for communicating with patients. It can also be utilized for research and therapeutic purposes by identifying patients who may benefit from life-saving clinical trials. This novel integrated diagnostic report will continue to show its value as medical science progresses.

Figure 3. Breast-IDR Pathology Page with Photomicrograph of a Biopsy Sample Showing Invasive Ductal Carcinoma.

UCLA Health Integrated Diagnostic Report
Home | New Case | Settings | How To | About Us | Log Out

Patient: Gender: F DOB: MRN: Physician: Date Created: 05-07-2020 Accession:
Clinical Information: 50-year-old female with DCIS with extensive calcifications in the left breast, found to have two masses in the superior breast on MRI. The mass biopsied at 11:00, 3 cm from the nipple.

ASSESSMENT
PATHOLOGY
RADIOLOGY
ANCILLARY STUDIES
TIMELINE
ALL IMAGES

PRINT
EXECUTIVE SUMMARY
ORGANIZE
OTHER REPORTS
EMAIL

PATHOLOGY Generated from original report by on May 7, 2020 9:49:44 PM | [REFERENCES](#)

MASS, 11:00, 3 CM FN, CT 1015 | 05-05-2020 | [SOURCE REPORT](#)

[ADDENDUM 1](#) | [Final Diagnosis](#) | [Clinical Information](#) | [Gross Description](#) | [Microscopic Exam](#) | [Immunohistochemistry](#) | [Images](#)

FINAL DIAGNOSIS

BREAST, LEFT, 11:00, 3 CM FN, MASS (CORE NEEDLE BIOPSY):

- Invasive ductal carcinoma with focal lobular features, Grade 1 (10% of biopsy sample; largest contiguous focus 4.5 mm)
- Modified Bloom and Richardson score: 4 of 9
 - Tubule formation: 2
 - Nuclear pleomorphism: 1
 - Mitotic score: 1 (<1 per 10 hpf; 0.55 mm field diameter)
- No in situ component identified
- Lymph/vascular invasion: Not identified
- Microcalcifications: Not identified
- See immunostain report below, which is compatible
- Breast biomarkers and HER2 FISH: Pending; results will be reported in an addendum/separately

COMMENT: Result was communicated

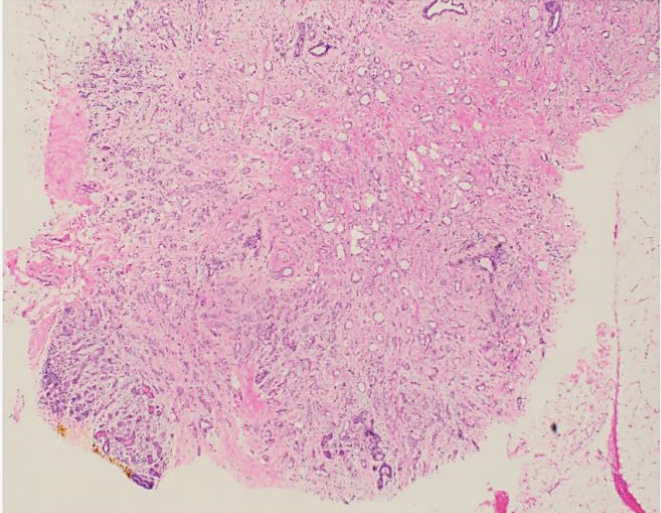


Figure 4. Breast-IDR Ancillary Studies Page Showing the Results of FISH Testing

Patient: Gender: F DOB: MRN: Physician: Date Created: 01/22/2020 Accession: Clinical Information: Irregular mass in the left breast at 3 o'clock, upper outer quadrant is highly suggestive of malignancy. BI-RADS Category 5

ASSESSMENT PATHOLOGY RADIOLOGY **ANCILLARY STUDIES** TIMELINE ALL IMAGES PRINT EXECUTIVE SUMMARY ORGANIZE OTHER REPORTS EMAIL

TESTS COMPLETED

FISH (AP)

SPECIMEN TYPE
Paraffin Embedded Tissue

TISSUE BLOCK
BREAST, LEFT MASS, 3:00, 4 CM FN (NEEDLE CORE BIOPSY)

CLINICAL INFORMATION
Breast carcinoma

FISH REPORT
ERBB2 (HER2) FISH: Negative for HER2 gene amplification
HER2/Centromere ratio: 1.46
Average HER2 copy number per cell: 2.85
Centromere (green signals): 39
HER2 (red signals): 57

KARYOTYPE
nuc ish(D17Z1x1-2,ERBB2x2-3)[20]

Figure 5. Breast-IDR Assessment Page with Links to Results of Biopsies of Several Sites.

Clinical Information: DCIS with extensive calcifications in the left breast, found to have two masses in the superior breast on MRI. The mass biopsied at 11:00, 3 cm from the nipple.

ASSESSMENT PATHOLOGY RADIOLOGY ANCILLARY STUDIES TIMELINE ALL IMAGES PRINT EXECUTIVE SUMMARY ORGANIZE OTHER REPORTS EMAIL

CONCORDANCE: This is concordant with the imaging findings.

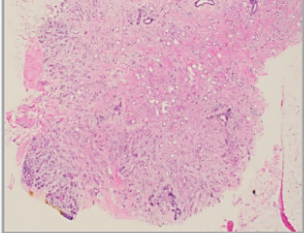
BIOPSY SITE: In the left breast upper inner quadrant at 11 o'clock located 3 centimeters from the nipple.

PATHOLOGY REPORTED AS: Malignant in the left breast upper inner quadrant at 11 o'clock located 3 centimeters from the nipple.

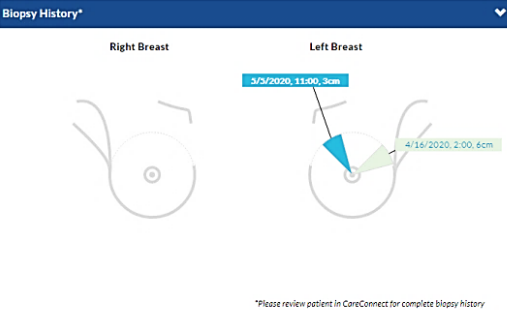
RECOMMENDATION: Recommend surgical and oncological consultations at this time for further management. Recommend ongoing surgical and oncological management. This biopsy site at 11:00, 3 cm from nipple was only visible on MRI and was not associated with a mammographic group of microcalcifications.

ADDITIONAL FINDINGS: [Please click here for further follow-up recommendations](#)

Pathology



Biopsy History*



*Please review patient in CareConnect for complete biopsy history

The biopsy sites specified by the blue (Left Breast 11:00, 3 cm FN) and the green (Left Breast 2:00, 6 cm FN) hyperlink labels with color-coordinated arrows. The photomicrograph of lesional biopsy specimen corresponds with the highlighted blue label and arrow. The green (dimmed) label and arrow provide access to the results of biopsy from the second site. Note the prominent concordance assessment statement on the first line of the report. Presented in every case of the Breast-IDR, this statement provides a clinician with clarity regarding adequacy of sampling and consistency of histologic and radiologic findings.

Figure 6. Breast-IDR Assessment Page with the Stereotactic Biopsy Image Showing Radial Scar.

UCLA Health Integrated Diagnostic Report

Home | New Case | Settings | How To | About Us | Log Out | *lidoepke*

Patient: Gender: F DOB: MRN: Physician: Doepke, Laura, MD Date Created: 05-08-2020 Accession: Diagnostic Imaging shows an area of architectural distortion in the left breast at 3 o'clock, upper outer quadrant at middle depth. BIRADS 4B.

ASSESSMENT | PATHOLOGY | RADIOLOGY | ANCILLARY STUDIES | TIMELINE | ALL IMAGES | PRINT | EXECUTIVE SUMMARY | ORGANIZE | OTHER REPORTS | EMAIL

CONCORDANCE: This is concordant with the imaging findings.

BIOPSY SITE: In the left breast at 3 o'clock located 5 centimeters from the nipple.

PATHOLOGY REPORTED AS: High risk in the left breast at 3 o'clock located 5 centimeters from the nipple.

RECOMMENDATION: Recommend surgical consultation.

ADDITIONAL FINDINGS: [Please click here for further follow-up recommendations](#)

Reviewed by Doepke, Laura R., MD on May 8, 2020 8:53:04 AM

Radiology

MM LEFT BREAST BIOPSY STEREO CORE
VACUUM ASSISTED 1-6

Biopsy History*

Right Breast Left Breast

3/4/2020, 3:00, 5cm

*Please review patient in CareConnect for complete biopsy history

The patient had additional findings that require follow-up. The "Additional Findings" section has a hyperlink (yellow ellipse) pointed to follow-up recommendations.

Figure 7. Breast-IDR Radiology Page Showing Follow-up Recommendations.

UCLA Health Integrated Diagnostic Report

Home | New Case | Settings | How To | About Us | Log Out

Patient: Gender: F DOB: MRN: Physician: Doepke, Laura, MD Date Created: Accession: Clinical Information: woman with a history of right breast invasive ductal carcinoma status-post mastectomy Also history of left breast explantation/mastectomy and surgical biopsy of left breast. Diagnostic Imaging shows an area of architectural distortion in the left breast at 3 o'clock, upper outer quadrant at middle depth. BIRADS 4B.

ASSESSMENT | PATHOLOGY | RADIOLOGY | ANCILLARY STUDIES | TIMELINE | ALL IMAGES | PRINT | EXECUTIVE SUMMARY | ORGANIZE | OTHER REPORTS | EM

CONCLUSIONS

Impression

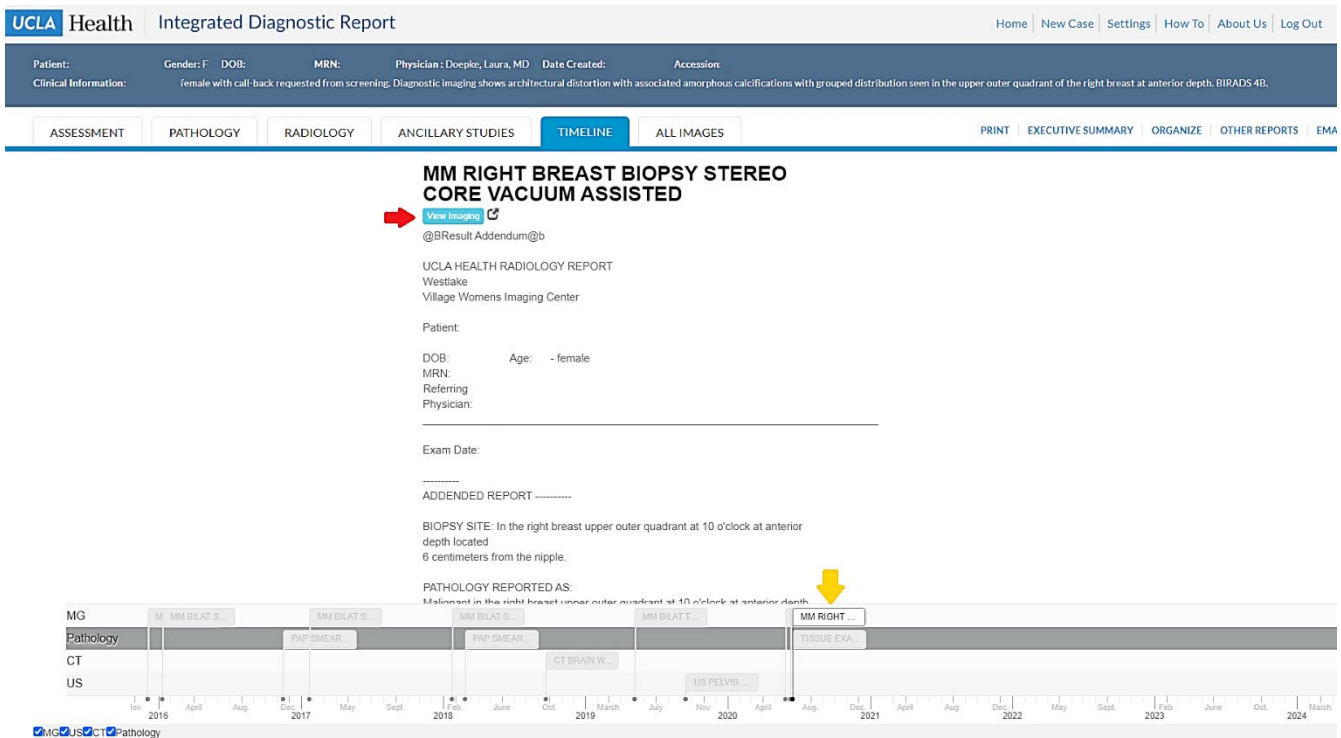
Finding 1: Area of architectural distortion in the left breast at 3 o'clock, upper outer quadrant at middle depth is suspicious. A stereotactic guided biopsy is recommended.

Finding 2: Finding in the right breast at 1 o'clock located 10 centimeters from the nipple is probably benign. Follow-up ultrasound in 6 months is recommended.

The patient was informed of the exam results by the radiologist before leaving the facility. The patient understands the importance of following-up with the recommended procedure.

No. 1. (Slice:21)

This page can be opened through a hyperlink in the "Additional Findings" section on the Assessment page of the Breast-IDR. Any finding that requires follow-up is highlighted (yellow highlight) and provided with the recommended imaging modality and follow-up time interval.

Figure 8. Breast-IDR Timeline Page.

The highlighted report (gray bar) of the shown study is mapped onto the timeline of the patient's clinical and diagnostic history (yellow arrow). The blue "View Imaging" button (red arrow) provides access to the case-relevant images.

Author Contributions

Conceptualization, D.E. and L.D.; Acquisition, analysis, interpretation of data, and writing – original draft preparation, L.D.; Review and editing, C.A., A.H., and D.E.; Supervision, D.E. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Disclosures

None to report.

References

- Berg WA, Hruban RH, Kumar D, Singh HR, Brem RF, Gatewood OM. Lessons from mammographic-histopathologic correlation of large-core needle breast biopsy. *Radiographics*. 1996;16(5): 1111-1130. doi: [10.1148/radiographics.16.5.8888394](https://doi.org/10.1148/radiographics.16.5.8888394)
- Mihalik JE, Krupka L, Davenport R, Tucker L, Toevs C, Smith RS. The rate of imaging-histologic discordance of

- benign breast disease: a multidisciplinary approach to the management of discordance at a large university-based hospital. *Am J Surg*. 2010;199(3):319-323. doi: [10.1016/j.amjsurg.2009.11.004](https://doi.org/10.1016/j.amjsurg.2009.11.004)
- Tsutsui JM, Jung G, Bahia Kerbauy DM, Rizzatti EG. Integrated diagnostic report: a Brazilian experience to improve the diagnostic process and foster professional learning. *J Am Coll Radiol*. 2018;15(11):1603-1608. doi: [10.1016/j.jacr.2017.11.033](https://doi.org/10.1016/j.jacr.2017.11.033)
- Guorgui J, Kinnaird A, Jayadevan R, Priester AM, Arnold CW, Marks LS. An electronic form for reporting results of targeted prostate biopsy: urology integrated diagnostic report (Uro-IDR). *Urology*. 2020;138:188-193. doi: [10.1016/j.urology.2020.01.015](https://doi.org/10.1016/j.urology.2020.01.015)
- Arnold CW, Wallace WD, Chen S, et al. RadPath: a web-based system for integrating and correlating radiology and pathology findings during cancer diagnosis. *Acad Radiol*. 2016;23(1):90-100. doi: [10.1016/j.acra.2015.09.009](https://doi.org/10.1016/j.acra.2015.09.009)
- Filice RW. Radiology-pathology correlation to facilitate peer learning: an overview including recent artificial intelligence methods. *J Am Coll Radiol*. 2019;16(9 Pt B):1279-1285. doi: [10.1016/j.jacr.2019.05.010](https://doi.org/10.1016/j.jacr.2019.05.010)
- Sorace J, Aberle DR, Elimam D, Lawvere S, Tawfik O, Wallace WD. Integrating pathology and radiology disciplines: an emerging opportunity? *BMC Medicine*. 2012;10:100. Published online September 5, 2012. doi: [10.1186/1741-7015-10-100](https://doi.org/10.1186/1741-7015-10-100)