



Contrast Enhanced Mammography

(CE2D/CEDM) Selected Bibliography

Updated June 2019

	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Contrast enhanced digital mammography versus magnetic resonance imaging for accurate measurement of the size of breast cancer.</p> <p>Youn I, Choi S, Choi YJ, Moon JH, Park HJ, Ham SY, Park CH, Kim EY, Kook SH. Br J Radiol. 2019 Jun;92(1098):20180929. doi: 10.1259/bjr.20180929. Epub 2019 Apr 24.</p> <p>*Key Point: For measuring of tumor size of breast cancer, CEDM was accurate in measurements.</p>	19-Jun		X					
<p>Added value of contrast-enhanced mammography in assessment of breast asymmetries.</p> <p>Wessam R, Gomaa MMM, Fouad MA, Mokhtar SM, Tohamey YM. Br J Radiol. 2019 Jun;92(1098):20180245. doi: 10.1259/bjr.20180245. Epub 2019 May 15.</p> <p>*Key Point: There is value to adding CESM in evaluating symmetries detected in screening and diagnostic mammography.</p>	19-Jun				X			
<p>Evaluation of single-view contrast-enhanced mammography as novel reading strategy: a non-inferiority feasibility study.</p> <p>Lobbes MBI, Hecker J, Houben IPL, Pluymakers R, Jeukens C, Laji UC, Gommers S, Wildberger JE, Nelemans PJ. Eur Radiol. 2019 May 9. doi: 10.1007/s00330-019-06215-7. [Epub ahead of print]</p> <p>*Key Point: When compared to 2-views, the 1-view had lower diagnostic performance.</p>	19-May	X			X			
<p>Comparison of Contrast-Enhanced Mammography With Conventional Digital Mammography in Breast Cancer Screening: A Pilot Study.</p> <p>Kim G, Phillips J, Cole E, Brook A, Mehta T, Slanetz P, Fishman MDC, Karimova E, Mehta R, Lotfi P, Resteghini N, Raj S, Dialani V. J Am Coll Radiol. 2019 May 16. pii: S1546-1440(19)30440-5. doi: 10.1016/j.jacr.2019.04.007. [Epub ahead of print]</p> <p>*Key Point: A trend was noted toward enhanced confidence with increasing tissue density with CEM.</p>	19-May	X			X			
<p>Diagnostic Value of Contrast-Enhanced Spectral Mammography in Comparison to Magnetic Resonance Imaging in Breast Lesions.</p> <p>Xing D, Lv Y, Sun B, Xie H, Dong J, Hao C, Chen Q, Chi X. J Comput Assist Tomogr. 2019 Mar/Apr;43(2):245-251. doi: 10.1097/RCT.0000000000000832.</p> <p>*Key Point: Results of the study demonstrated that for breast cancer detection, CEDM has better accuracy, specificity, and false-positive rates than MRI.</p>	19-Mar		X					

	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Contrast-enhanced spectral mammography in the evaluation of breast suspicious calcifications: diagnostic accuracy and impact on surgical management.</p> <p>Houben IP, Vanwetswinkel S, Kalia V, Thywissen T, Nelemans PJ, Heuts EM, Smidt ML, Meyer-Baese A, Wildberger JE, Lobbes M Acta Radiologica - 2019 Jan 24;284185118822639. doi: 10.1177/0284185118822639</p> <p>*Key Point: The diagnostic accuracy of evaluating breast calcifications is only slightly improved with CESM.</p>	19-Jan				X			
<p>Contrast-Enhanced Mammography: A Systematic Guide to Interpretation and Reporting.</p> <p>Perry H, Phillips J, Dialani V, Slanetz PJ, Fein-Zachary VJ, Karimova EJ, Mehta TS AJR Am J Roentgenol. 2019 Jan;212(1):222-231. doi: 10.2214/AJR.17.19265. Epub 2018 Nov 1.</p> <p>*Key Point: Article provides guidance for implementing contrast enhanced mammography procedures into a clinical practice.</p>	19-Jan	X						
<p>Diagnostic Value of Contrast-Enhanced Digital Mammography versus Contrast-Enhanced Magnetic Resonance Imaging for the Preoperative Evaluation of Breast Cancer.</p> <p>Kim EY, Youn I, Lee KH, Yun JS, Park YL, Park CH, Moon J, Choi SH, Choi YJ, Ham SY, Kook SH. J Breast Cancer. 2018 Dec;21(4):453-462. doi: 10.4048/jbc.2018.21.e62. Epub 2018 Dec 26</p> <p>*Key Point: In comparison to CEMRI, CEDM demonstrated a comparable diagnostic performance in the area of showing index cancers, secondary cancers, and occult cancer in the contralateral breast.</p>	18-Dec		X					
<p>Preoperative imaging for breast conservation surgery-do we need more than conventional imaging for local disease assessment?</p> <p>Ong E. – Gland Surgical Journal - 2018 Dec;7(6):554-559. doi: 10.21037/gj.2018.08.05.</p> <p>*Key Point: In this retrospective study of 27 procedures, CESM demonstrated more secondary cancers than MRI - (100% vs. 91%)</p>	18-Dec		X					
<p>Role of contrast-enhanced spectral mammography in the post biopsy management of B3 lesions: Preliminary results.</p> <p>Bicchierai G, Nori J, De Benedetto D1, Boeri C, Vanzi E, Bianchi S, Kaur Gill M, Cirone D, Miele V. Tumori. 2018 Dec 17;300891618816212. doi: 10.1177/0300891618816212</p> <p>*Key Point: Utilizing the BI-RADS classifications, results of CESM procedures are classified to aid in the next steps for post biopsy management of BI-RADS 3 lesions.</p>	18-Dec				X		X	



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<p>ASO Author Reflections: Role of Contrast-Enhanced Spectral Mammography in the Assessment of Residual Breast Cancer After Neoadjuvant Systemic Therapy. Hilal T, Patel BK. Ann Surg Oncol. 2018 Dec;25(Suppl 3):652-653. doi: 10.1245/s10434-018-6899-2. *Key Point: When assessing residual breast cancer after neoadjuvant systemic therapy, the accuracy of CESM is comparable to bMRI.</p>	18-Dec		X					
<p>Diagnostic Value of Contrast-Enhanced Spectral Mammography in Comparison to Magnetic Resonance Imaging in Breast Lesions. Xing D, Lv Y, Sun Z, Xie H, Dong J, Hao C, Chen Q, Chi X. J Comput Assist Tomogr. 2018 Dec 7. doi: 10.1097/RCT.0000000000000832. *Key Point: A comparison between CESM and MRI demonstrates better accuracy, specificity, and false-positive rate with CESM in detecting breast cancer.</p>	18-Dec		X					
<p>Contrast-Enhanced Spectral Mammography in Women With Intermediate Breast Cancer Risk and Dense Breasts. Sorin V, Yagil Y, Yosepovich A, Shalmon A, Gotlieb M, Neiman OH, Sklair-Levy M. AJR Am J Roentgenol. 2018 Nov;211(5):W267-W274. doi: 10.2214/AJR.17.19355. Epub 2018 Sep 21 *Key Point: For women at intermediate risk who have dense breasts, CESM may be a valuable supplemental screening modality.</p>	18-Nov						X	
<p>Comparative Dose of Contrast-Enhanced Spectral Mammography (CESM), Digital Mammography, and Digital Breast Tomosynthesis. Phillips J, Mihai G, Hassonjee SE, Raj SD, Palmer MR, Brook A, Zhang D. AJR Am J Roentgenol. 2018 Oct;211(4):839-846. doi: 10.2214/AJR.17.19036. Epub 2018 Jul 31. *Key Point: As a diagnostic tool, CESM has an acceptable range for dose compared to other mammographic exams.</p>	Oct-18			X				
<p>Contrast-Enhanced Spectral Mammography in Women With Intermediate Breast Cancer Risk and Dense Breasts. Sorin V, Yagil Y, Yosepovich A, Shalmon A, Gotlieb M, Neiman OH, Sklair-Levy M. AJR Am J Roentgenol. 2018 Sep 21:W1-W8. doi: 10.2214/AJR.17.19355. [Epub ahead of print] *Key Point: Women with intermediate breast cancer risk and dense breast tissue benefit from a CESM procedure due to it's higher sensitivity.</p>	Sep-18				X			



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<p>The impact of contrast-enhanced spectral mammogram (CESM) and three-dimensional breast ultrasound (3DUS) on the characterization of the disease extend in cancer patients</p> <p>Helal MH, Mansour SM, Salaleldin LA, Alkalaawy BM, Salem DS, Mokhtar NM Br J Radiol. 2018 Jul;91(1087):20170977. doi: 10.1259/bjr.20170977. Epub 2018 May 24</p> <p>*Key Point: In comparison to 3DUS, CESM was the most accurate modality for determining tumor size and multiplicity of intramammary cancer.</p>	Jul-18				X			
<p>Contrast-enhanced spectral mammography (CESM)</p> <p>James JJ, Tennant SL Clin Radiol. 2018 Aug;73(8):715-723. doi: 10.1016/j.crad.2018.05.005. Epub 2018 Jun 21.</p> <p>*Key Point: CESM improves diagnostic accuracy, especially in women with denser breast tissue.</p>	Aug-18	X			X			
<p>Value Added of Preoperative Contrast-Enhanced Digital Mammography in Patients With Invasive Lobular Carcinoma of the Breast</p> <p>Patel BK, Davis J, Ferraro C, Kosiorek H, Hasselbach K, Ocal T, Pockaj B. Clin Breast Cancer. 2018 Jul 17. pii: S1526-8209(18)30371-9. doi: 10.1016/j.clbc.2018.07.012. [Epub ahead of print]</p> <p>*Key Point: Patients with biopsy-proven invasive lobular carcinoma, CEDM outperforms standard digital mammography in correctly assessing the extent of the disease.</p>	Jul-18	X					X	
<p>The impact of contrast-enhanced spectral mammogram (CESM) and three-dimensional breast ultrasound (3DUS) on the characterization of the disease extend in cancer patients</p> <p>Helal MH, Mansour SM, Salaleldin LA, Alkalaawy BM, Salem DS, Mokhtar NM Br J Radiol. 2018 Jul;91(1087):20170977. doi: 10.1259/bjr.20170977. Epub 2018 May 24</p> <p>*Key Point: In comparison to 3DUS, CESM was the most accurate modality for determining tumor size and multiplicity of intramammary cancer.</p>	Jul-18				X			
<p>Diagnostic Value of Contrast-Enhanced Spectral Mammography for Screening Breast Cancer: Systematic Review and Meta-analysis</p> <p>Zhu X, Huang JM, Zhang K, Xia LJ, Feng L, Yang P, Zhang MY, Xiao W, Lin HX, Yu YH Clin Breast Cancer. 2018 Jun 15. pii: S1526-8209(18)30008-9. doi: 10.1016/j.clbc.2018.06.003.</p> <p>*Key Point: CESM is a useful test for initial assessment of breast lesions due to a high diagnostic accuracy for evaluating breast cancer.</p>	Jun-18	X						

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<p>Comparison of Contrast-Enhanced Mammography and Contrast-Enhanced Breast MR Imaging John Lewin - Magnetic Resonance Imaging Clinics of North America, Vol 26, Issue 2, May 2018, Pages 259-263 *Key Point: Compared to breast MR, contrast-enhanced mammography (CEM) has similar sensitivity and specificity. CEM has advantages in terms of cost, patient acceptability, and examination time.</p>	May-18		X					
<p>The impact of contrast enhanced spectral mammogram (CESM) and three dimensional breast ultrasound (3DUS) on the characterization of the disease extend in cancer patients Helal MH, Salem DS, Salaleldin LA, Mansour SM, Alkalaawy BM, Mokhtar NM Br J Radiol. 2018 Apr 11:20170977. doi: 10.1259/bjr.20170977. *Key Point: This prospective study found the use of CESM increased the accuracy of size measurement and the detection of multiple tumors.</p>	Apr-18	X						GE
<p>The added value of contrast enhanced spectral mammography (CESM) in identification of multiplicity of suspicious lesions in dense breast Amr Farouk Ibrahim Moustafa, Eman Faker Kamal, Maher M. Hassan, Mona Sakr, Mohammed Mohammed Mohammed Gomaa The Egyptian Journal of Radiology and Nuclear Medicine, Available online 2 April 2018 *Key Point: CESM demonstrated an added value in the preoperative assessment of breast masses increasing the accuracy of detection of lesions and multiplicity (multifocality and multicentricity).</p>	Apr-18				X			
<p>Workflow Considerations for Incorporation of Contrast-Enhanced Spectral Mammography Into a Breast Imaging Practice Phillips J, Steinkeler J, Talati K, Brook A, Dialani V, Fishman M, Slanetz PJ, Mehta TS J Am Coll Radiol. 2018 Mar 30. pii: S1546-1440(18)30205-9. doi: 10.1016/j.jacr.2018.02.012 *KeyPoint: Assesed and compared the workflow of CESM, DM,MRI and CT from pateient preparation to examination to post examination. The author outlined timing challenges if done</p>	Mar-18		X					
<p>Contrast-Enhanced Spectral Mammography is Comparable to MRI in the Assessment of Residual Breast Cancer Following Neoadjuvant Systemic Therapy Patel BK, Hilal T, Covington M, Zhang N, Kosiorek HE, Lobbes M, Northfelt DW, Pockaj BA. Ann Surg Oncol. 2018 May;25(5):1350-1356. doi: 10.1245/s10434-018-6413-x. Epub 2018 Mar 7. *Key Point: After the completion of NST, CESM was comparable to MRI in assessing residual malignancy.</p>	Mar-18		X					H

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<p>Contrast-enhanced spectral mammography. Experience in 465 examinations [Article in Spanish - Abstract] Navarro ME, Razmilic D, Araos I, Rodrigo A, Andia ME Revista Medical de Chile, 2018 Feb;146(2):141-149. doi: 10.4067/s0034-98872018000200141 *Key Point: After reviewing 465 contrast enhanced mammography studies, performed between July 2015 and October 2017, the authors found CESM sensitivity to be 100% and with diagnostic accuracy of 85%.</p>	Feb-18							
<p>Quantitative analysis of enhanced malignant and benign lesions on contrast-enhanced spectral mammography Deng CY, Juan YH, Cheung YC, Lin YC, Lo YF, Lin G, Chen SC, Ng SH Br J Radiol. 2018 Feb 27;20170605. doi: 10.1259/bjr.20170605 *Key Point: For assessing breast lesions, the quantities of enhancement were informative in which the malignancies had stronger enhancement and more relative depressed enhancement than the benign lesions.</p>	Feb-18						X	
<p>The Future of Contrast-Enhanced Mammography Covington MF, Pizzitola VJ, Lorans R, Pockaj BA, Northfelt DW, AppletonCM, Patel BK AJR:210, February 2018 *Key Point: Contrast Enhanced Mammography (CEM), when compared to breast MRI, permits fast contrast imaging with lower costs, imaging and interpretation times.</p>	Feb-18		X	X		X		H
<p>Computer-Aided Diagnosis of Contrast-Enhanced Spectral Mammography: A Feasibility Study Patela BK, Ranjbarb S, Teresa Wue T, Pockajc BA, Lie J, Zhangd N, Lobbesf M, Zhengg B, Mitchell JR European Journal of Radiology - online 5 December 2017 *Key Point: The feasibility study proposes that the use of CAD with CESM will help reduce the number of false-positive findings.</p>	Dec-17	X					X	H
<p>Dual energy contrast enhanced (DECE) soft tissue digital mammography versus ultrasound elastography in the evaluation of breast masses Ayman M.A.M. Nada, Rashad Hamdi, Ahmed Shokry The Egyptian Journal of Radiology and Nuclear Medicine, Volume 48, Issue 4, December 2017, Pages 1179-1186 *Key Point: In this study of 32 patients, DECE demonstrated a considerable increase in the sensitivity without a reduction in specificity.</p>	Dec-17							GE



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<p>Comparison of screening CEDM and MRI for women at increased risk for breast cancer: A pilot study</p> <p>Jochelson MS, Pinker K, Dershaw DD, Hughes M, Gibbons GF, Rahbar K, Robson ME, Mangino DA, Goldman D, Moskowitz CS, Morris EA, Sung JS. Eur J Radiol. 2017 Dec;97:37-43. Epub 2017 Oct 7.</p> <p>*Key Point: Because CEDM is able to detect additional cancers, especially invasive cancers, that are not seen on conventional mammography, the procedure would be valuable for women who do not have access to MRI or meet the criteria for MRI.</p>	Dec-17	X	X				X	GE
<p>Clinical utility of contrast-enhanced spectral mammography as an adjunct for tomosynthesis-detected architectural distortion</p> <p>Patel BK, Naylor ME, Kosiorek HE, Lopez-Alvarez YM, Miller AM, Pizzitola VJ, Pockaj BA Clinical Imaging - Volume 46, November–December 2017, Pages 44-52</p> <p>*Key Point: This article provides a retrospective review: In cases of tomosynthesis-detected architectural distortion, the high sensitivity of CESM is promising as an adjunct tool for radiologists in diagnosing malignancies and avoiding needless biopsies.</p>	Dec-17	X			X		X	H
<p>Assessing tumor extent on contrast-enhanced spectral mammography (CEDM) versus full-field digital mammography and ultrasound</p> <p>Bhavika K. Patel, Sandra Alheli Garza, Sarah Eversman, Yania Lopez-Alvarez, Heidi Kosiorek, Barbara A. Pockaj Clinical Imaging, Volume 46, November–December 2017, Pages 78-84</p> <p>*Key Point: This study found that the addition of CEDM, as a supplement to FFDM for determining tumor size, was beneficial for patients with dense breasts.</p>	Nov-17				X			H
<p>Contrast-enhanced spectral mammography as work-up tool in patients recalled from breast cancer screening has low risks and might hold clinical benefits</p> <p>I.P.L. Houben, P. Van de Voorde, C.R.L.P.N. Jeukens, J.E. Wildberger, L.F. Kooreman, M.L. Smidt, M.B.I. Lobbes European Journal of Radiology, Volume 94, September 2017, Pages 31-37</p> <p>*Key Point: The authors recommend using CESM as a work-up tool for women recalled from screening, because it carries low risk for the patient, while additionally detecting tumour foci might hold important clinical implications.</p>	Sep-17				X		X	

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<p>Contrast-enhanced spectral mammography in neoadjuvant chemotherapy monitoring: a comparison with breast magnetic resonance imaging</p> <p>Lotti V, Ravaioli S, Vacondio R, Coriani C, Caffarri S, Sghedoni R, Nitrosi A, Ragazzi M, Gasparini E, Masini C, Bisagni G, Falco G, Ferrari G, Braglia L, Del Prato A, Malavolti I, Ginocchi V, Pattacini P Breast Cancer Res. 2017; 19: 106. Published online 2017 Sep 11.</p> <p>*Key Point: CESM is at least as reliable as MRI in assessing the response to neoadjuvant chemotherapy treatment. Lesion size measurements were highly correlated between CESM & MRI.</p>	Sep-17		X		X			GE
<p>Could parenchymal enhancement on contrast-enhanced spectral mammography (CESM) represent a new breast cancer risk factor? Correlation with known radiology risk factors</p> <p>S.L. Savaridas, D.B. Taylor, D. Gunawardana, M. Phillips - Clinical Radiology Available online 1 September 2017</p> <p>*Key Point: CESM is better than CEMRI for inter-reader reliability in grading breast parenchymal enhancement.</p>	Sep-17		X				X	GE
<p>Contrast Enhanced Spectral Mammography: A Review</p> <p>Bhavika K. Patel, M.B.I. Lobbes, John Lewin - Seminars in Ultrasound, CT and MRI Avail. online 24 August 2017</p> <p>*Key Point: Contrast Enhanced Spectral Mammography (CESM) is being adopted for several indications that were previously earmarked for MRI.</p>	Aug-17		X				X	H
<p>Assessing tumor extent on contrast-enhanced spectral mammography versus full-field digital mammography and ultrasound.</p> <p>Patel BK, Garza SA, Eversman S, Lopez-Alvarez Y, Kosiorek H, Pockaj BA - Clinical Imaging. 2017 Jul 12;46:78-84. doi: 10.1016/j.clinimag.2017.07.001</p> <p>*Key Point: CEDM procedure is an added value to FFDM in determining tumor size, however, was greater in patients with dense breasts.</p>	Jul-17	X			X			H
<p>Clinical utility of contrast-enhanced spectral mammography as an adjunct for tomosynthesis-detected architectural distortion.</p> <p>Patel BK, Naylor ME, Kosiorek HE, Lopez-Alvarez YM, Miller AM, Pizzitola VJ, Pockaj BA - Clin Imaging. 2017 Jul 12;46:44-52. doi: 10.1016/j.clinimag.2017.07.003</p> <p>*Key Point: Retrospective review CESM prior to biopsied AD architectural distortions (AD) High sensitivity and NPV of CESM in patients with AD is promising as an adjunct tool in diagnosing malignancy and avoiding unnecessary biopsy, respectively.</p>	Jul-17	X					X	H

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<p>Indeterminate breast lesions: Can contrast enhanced digital mammography change our decisions?</p> <p>Samira Saraya, Lamia Adel, Asmaa Mahmoud - The Egyptian Journal of Radiology and Nuclear Medicine Volume 48, Issue 2, June 2017, Pages 547-552</p> <p>*Key Point: By assessing the efficiency of contrast enhanced digital mammography (CEDM) for indeterminate lesions (BIRADS 3 and 4) proved to be a useful tool for breast cancer detection.</p>	Jun-17				X		X	GE
<p>Role of contrast enhanced spectral mammography in predicting pathological response of locally advanced breast cancer post neo-adjuvant chemotherapy</p> <p>Noha Abd ElShafy ElSaid, Hebatallah G.M. Mahmoud, Asmaa Salama, Marwa Nabil, Eman D. ElDesouky - The Egyptian Journal of Radiology and Nuclear Medicine Volume 48, Issue 2, June 2017, Pages 519-527</p> <p>*Key Point: CESM can be a clinical method for assessment of the pathological response post NAC which aids in surgical planning.</p>	Jun-17				X		X	GE
<p>Potential Cost Savings of Contrast-Enhanced Digital Mammography.</p> <p>Patel BK, Gray RJ, Pockaj BA - AJR Am J Roentgology. 2017 Apr:1-7. doi: 10.2214/AJR.16.17239 (Epub ahead of print)</p> <p>*Key Point: This study looks at both the efficacy of CEDM compared to BMRI, but also goes into the cost implications for both patient and institution. The author considers capital purchase, equipment, staffing and other costs related to both types of exams. The author states a potential savings to the healthcare system of \$1.1 billion.</p>	Jun-17		X	X		X	X	H
<p>Staging of breast cancer and the advanced applications of digital mammogram: what the physician needs to know?</p> <p>Helal MH, Mansour SM, Zaglol M, Salaleldin LA, Nada OM, Haggag MA - Br J Radiol. 2017 Mar;90(1071):20160717. doi: 10.1259/bjr.20160717. Epub 2017 Feb 22.</p> <p>*Key Point: This prospective study evaluated 98 proven malignant breast masses and determined that CEDM and tomosynthesis present an informative method for staging of breast cancer.</p>	Mar-17	X	X					GE



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<p>Contrast-enhanced spectral mammography (CESM) versus MRI in the high-risk screening setting: patient preferences and attitudes.</p> <p>Phillips J, Miller MM, Mehta TS, Fein-Zachary V, Nathanson A, Hori W, Monahan-Earley R, Slanetz PJ - Clin Imaging. 2017 Mar - Apr;42:193-197. doi: 10.1016/j.clinimag.2016.12.011.</p> <p>*Key Point: The prospective study, with high risk patients, reviewed their exams of BMRI and CESM. Seventy-nine percent (79%) of the patients preferred CESM over MRI and 89% would be agreeable to having CESM as an annual screening.</p>	Mar-17	X	X					GE
<p>Contrast-enhanced spectral mammography (CESM) vs. breast magnetic resonance imaging (MRI): A retrospective comparison in 66 breast lesions.</p> <p>Li L, Roth R, Germaine P, Ren S, Lee M, Hunter K, Tinney E, Liao L. - Diagn Interv Imaging. 2017 Feb;98(2):113-123. doi: 10.1016/j.diii.2016.08.013. Epub 2016 Sep 26</p> <p>*Key Point: CESM, compared to BMRI, has a higher PPV, less background enhancement, and similar sensitivity in detecting breast cancer. With its shorter exam time and more accessible than BMRI, CESM has the potential to be an important tool in detection and staging of breast cancer.</p>	Feb-17	X	X				X	GE
<p>Breast Radiation Dose With CESM Compared With 2D FFDM and 3D Tomosynthesis Mammography</p> <p>James JR, Pavlicek W, Hanson JA, Boltz TF, Patel BK - AJR Am J Roentgenology. 2017 Feb;208(2):362-372. doi: 10.2214/AJR.16.16743</p> <p>*Key Point: Compared the radiation dose with 3 different methods of mammography (CEDM, FFDM and 3D Tomosynthesis). The author concluded that while CEDM increased the mGY exposure slightly in a mean thickness of 63mm it stayed well below the 3.0mGY limit set MQSA regulations.</p>	Feb-17			X				H
<p>Contrast-enhanced Spectral Mammography: Technique, Indications, and Clinical Applications.</p> <p>Bhimani C, Matta D, Roth RG, Liao L, Tinney E, Brill K, Germaine P. - Acad Radiol. 2017 Jan;24(1):84-88. doi: 10.1016/j.acra.2016.08.019. Epub 2016 Oct 20.</p> <p>*Key Point: It is important to understand the technique of CESM and practical applications before incorporating it into practice.</p>	Jan-17	X			X	X		GE



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<p>Contrast-enhanced spectral mammography in recalls from the Dutch breast cancer screening program: validation of results in a large multireader, multicase study.</p> <p>Lalji UC, Houben IP, Prevos R, Gommers S, van Goethem M, Vanwetswinkel S, Pijnappel R, Steeman R, Frotscher C, Mok W, Nelemans P, Smidt ML, Beets-Tan RG, Wildberger JE, Lobbes MB. - Eur Radiol. 2016 Dec;26(12):4371-4379. Epub 2016 Apr 20.</p> <p>*Key Point: CESM is consistently superior to conventional mammography. CESM increases diagnostic accuracy regardless of a reader's experience. CESM is an excellent problem-solving tool in recalls from screening programs.</p>	Dec-16	X			X	X	X	GE
<p>Contrast-enhanced spectral mammography vs. mammography and MRI - clinical performance in a multi-reader evaluation.</p> <p>Fallenberg EM, Schmitzberger FF, Amer H, Ingold-Heppner B, Balleyguier C, Diekmann F, Engelken F, Mann RM, Renz DM, Bick U, Hamm B, Dromain C. - Eur Radiol. 2016 Nov 28.</p> <p>*Key Point: CESM has comparable diagnostic performance (ROC-AUC) to MRI for breast cancer.</p>	Nov-16	X	X		X		X	GE
<p>Adding the power of iodinated contrast media to the credibility of mammography in breast cancer diagnosis.</p> <p>Tsigginou A, Gkali C2, Chalazonitis A, Feida E, Vlachos DE, Zagouri F, Rellias I, Dimitrakakis C. - Br J Radiol. 2016 Nov;89(1067):20160397. Epub 2016 Aug 9.</p> <p>*Key Point: Malignancy potential score (MPS) has higher diagnostic performance than digital mammography or CESM alone. MPS empowers the credibility of the digital mammography BIRADS score and the proposed type of enhancement in dual-energy CESM and is a diagnostic tool that increases the accuracy rate in early breast cancer diagnosis.</p>	Nov-16	X					X	GE
<p>Contrast-enhanced spectral mammography improves diagnostic accuracy in the symptomatic setting.</p> <p>Tennant SL, James JJ, Cornford EJ, Chen Y, Burrell HC, Hamilton LJ, Girio-Fragkoulakis C. - Clin Radiol. 2016 Nov;71(11):1148-55. doi: 10.1016/j.crad.2016.05.009. Epub 2016 Jun 11.</p> <p>*Key Point: CESM provides immediately available, clinically useful information in the clinic for patients with suspicious palpable abnormalities. Radiologist sensitivity, specificity, and size accuracy for breast cancer detection and staging are all improved using CESM as the primary mammographic investigation.</p>	Nov-16	X			X		X	GE

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<p>Degree of Enhancement on Contrast Enhanced Spectral Mammography (CESM) and Lesion Type on Mammography (MG): Comparison Based on Histological Results. Łuczyńska E, Niemiec J, Hendrick E, Heinze S1 Jaszczurki J, Jakubowicz J, Sas-Korczyńska B, Rys J. - Med Sci Monit. 2016 Oct 21;22:3886-3893. *Key Point: Strong or medium enhancement on CESM and mass or mass with microcalcifications on MG were strong indicators of malignant transformation. However, no combination of MG and CESM characteristics helpful in defining false-positive lesions were found.</p>	Oct-16	X					X	GE
<p>Contrast-enhanced Digital Mammography: A Single-Institution Experience of the First 208 Cases. Lewis TC, Pizzitola VJ, Giurescu ME, Eversman WG, Lorans R, Robinson KA, Patel BK. - Breast J. 2016 Oct 2. doi: 10.1111/tbj.12681 *Key Point: Given its success in recent studies and the experience of CEDM primarily as a diagnostic adjunct, CEDM can potentially improve breast cancer detection by combining the low-cost conclusions of screening mammography with the high sensitivity of magnetic resonance imaging.</p>	Oct-16	X	X		X	X		H
<p>Is contrast-enhanced spectral mammography (CESM) helpful in differentiating diabetic mastopathy from breast carcinoma? Travieso Aja MD, Santana López G, Rodríguez Rodríguez M, Luzardo OP. - J Med Imaging Radiat Oncol. 2016 Oct;60(5):639-641. doi: 10.1111/1754-9485.12446. Epub 2016 Mar 30. *Key Point: Diabetic mastopathy, a rare benign inflammatory disease, is evaluated and discussed in CESM studies. This disease often displays as a suspicious image of malignancy in ultrasound, mammography and breast MRI.</p>	Oct-16	X			X		X	
<p>Contrast-Enhanced Digital Mammography in the Surgical Management of Breast Cancer Ali-Mucheru M, Pockaj B, Patel B, Pizzitola V, Wasif N, Stucky CC, Gray R MAYO Clinic, Phoenix, AZ - Annals of Surgical Oncology, Published online September 15, 2016, DOI 10.1245/s10434-016-5567-7 *Key Point: The authors concluded that utilizing CEDM is low cost, relatively easy alternative to MRI for surgical planning and maintains the high sensitivity of bMRI.</p>	Sep-16		X			X		GE

Contrast Enhanced Mammography

(CE2D/CEDM) Selected Bibliography

Updated June 2019

	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Contrast-enhanced spectral mammography (CESM) vs. breast magnetic resonance imaging (MRI): A retrospective comparison in 66 breast lesions.</p> <p>Li L, Roth R, Germaine P, Ren S, Lee M, Hunter K, Tinney E, Liao L. - Diagn Interv Imaging. 2016 Sep 26. pii: S2211-5684(16)30212-1. doi: 10.1016/j.diii.2016.08.013.</p> <p>Key Point: CESM has similar sensitivity than BMRI in breast cancer detection, with higher PPV and less background enhancement. CESM is associate with significantly shorter exam time thus a more accessible alternative to BMRI, it has potential to play an important role in breast cancer detection and staging.</p>	Sep-16	X	X		X		X	H
<p>Dual-Energy Contrast-Enhanced Spectral Mammography: Enhancement Analysis on BI-RADS 4 Non-Mass Microcalcifications in Screened Women.</p> <p>Cheung YC, Juan YH, Lin YC, Lo YF, Tsai HP, Ueng SH, Chen SC. - PLoS One. 2016 Sep 9;11(9):e0162740. doi: 10.1371/journal.pone.0162740. eCollection 2016.</p> <p>*Key Point: Dual-energy contrast-enhanced spectral mammography (DE-CESM) might provide added value in assessing the non-mass screened breast microcalcification, with enhancement favorable to the diagnosis of cancers or lack of enhancement virtually diagnostic for non-malignant lesions or noninvasive subgroup cancers.</p>	Sep-16	X			X		X	GE
<p>Comparison of the Mammography, Contrast-Enhanced Spectral Mammography and Ultrasonography in a Group of 116 patients.</p> <p>Łuczyńska E, Niemiec J, Hendrick E, Heinze S1 Jaszczyński J, Jakubowicz J, Sas-Korczyńska B, Rys J - Anticancer Res. 2016 Aug; 36 (8):4359-66.</p> <p>*Key Point: CESM permitted better detection of malignant lesions than both MG and US read individually. CESM found lesion enhancement in some benign lesions as well, yielding a rate of false-positive diagnoses similar to that of MG and US.</p>	Aug-16	X			X		X	GE
<p>Diagnostic performance of contrast-enhanced spectral mammography: Systematic review and meta-analysis.</p> <p>Tagliafico AS, Bignotti B, Rossi F, Signori A, Sormani MP, Valdora F, Calabrese M, Houssami N. - Breast. 2016 Aug;28:13-9. doi: 10.1016/j.breast.2016.04.008. Epub 2016 May 7.</p> <p>*Key Point: The source studies were based on highly selected case series and prone to selection bias. High-quality studies are required to assess the accuracy of CESM in unselected cases.</p>	Aug-16	X					X	Mult

	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Comparison of Background Parenchymal Enhancement at Contrast-enhanced Spectral Mammography and Breast MR Imaging.</p> <p>Sogani J, Morris EA, Kaplan JB, D'Alessio D, Goldman D, Moskowitz CS, Jochelson MS. - Radiology. 2016 Jul 4:160284</p> <p>*Key Point: This study was conducted to assess the extent of background parenchymal enhancement (BPE) in CESM and bMRI. Inter-reader agreement in BPE assessment and examines the relationships between clinical factors and BPE.</p>	Jul-16	X	X					GE
<p>Preclinical study of diagnostic performances of contrast-enhanced spectral mammography versus MRI for breast diseases in China.</p> <p>Wang Q, Li K, Wang L, Zhang J, Zhou Z, Feng Y - Springerplus. 2016 Jun 17;5(1):763. doi: 10.1186/s40064-016-2385-0.</p> <p>*Key Point: Demonstrates that CESM possesses better diagnostic performances than breast MRI in terms of diagnostic sensitivity and lesion size assessment. Also that CESM is a good alternative method of screening breast cancer in high-risk people.</p>	Jun-16	X	X		X			GE
<p>Added Value of Contrast-Enhanced Spectral Mammography in Postscreening Assessment.</p> <p>Tardivel AM, Balleyguier C, Dunant A, Delaloge S, Mazouni C, Mathieu MC, Dromain C - Breast J. 2016 Sep;22(5):520-8. doi: 10.1111/tbj.12627. Epub 2016 Jun 27.</p> <p>*Key Point: CESM can be performed easily in a clinical assessment after positive breast cancer screening and may change significantly the diagnostic and treatment strategy through breast cancer staging.</p>	Jun-16	X			X	X		GE
<p>Challenges in contrast-enhanced spectral mammography interpretation: artefacts lexicon.</p> <p>Yagil Y, Shalmon A, Rundstein A, Servadio Y, Halshtok O, Gotlieb M, Sklair-Levy M. - Clin Radiol. 2016 May;71(5):450-7. doi: 10.1016/j.crad.2016.01.012. Epub 2016 Feb 18.</p> <p>*Key Point: Two main artefacts commonly seen on CESM are rim and ripple artefacts which do not hamper image interpretation. It is important to be aware of them and prevent misinterpretation of these artefacts as real breast pathology.</p>	May-16	X						GE
<p>A Case of a Concurrent and Co-Located Invasive Carcinoma and a Fibroadenoma to Illustrate the Potential of Dual-Energy, Contrast-Enhanced Digital Mammography on the Diagnosis of Complex Breast Lesions.</p> <p>Travieso Aja MD, Munoz P, Rodriguez Rodriguez M, Vega Benitez V, Luzardo OP. - Iran J Radiol. 2016 Apr 25;13(3):e32190.</p> <p>*Key Point: Being less costly than bMRI, CESM may constitute a good alternative for improving diagnostic sensitivity in these countries.</p>	Apr-16	X	X			X	X	GE

	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Clinical utility of dual-energy contrast-enhanced spectral mammography for breast microcalcifications without associated mass: a preliminary analysis.</p> <p>Cheung YC, Tsai HP, Lo YF, Ueng SH, Huang PC, Chen SC. - Eur Radiol. 2016 Apr;26(4):1082-9. doi: 10.1007/s00330-015-3904-z. Epub 2015 Jul 10.</p> <p>*Key Point: Dual-energy contrast-enhanced spectral mammography (DE-CESM) provides additional enhancement information for diagnosing suspicious breast microcalcifications.</p>	Apr-16	X			X		X	GE
<p>Diagnostic accuracy of contrast-enhanced spectral mammography in comparison to conventional full-field digital mammography in a population of women with dense breasts.</p> <p>Mori M, Akashi-Tanaka S, Suzuki S, Daniels MI, Watanabe C, Hirose M, Nakamura S. - Breast Cancer. 2016 Mar 4.</p> <p>*Key Point: These findings suggest that CESM offers superior clinical performance compared to FFDM. Use of CESM may decrease false negatives especially for women with dense breasts.</p>	Mar-16	X			X			GE
<p>Clinical evaluation of contrast-enhanced digital mammography & contrast enhanced tomosynthesis - Comparison to contrast-enhanced bMRI</p> <p>Chou CP, Lewin JM, Chiang CL, Hung BH, Yang TL, Huang JS, Liao JB, Pan HB. Eur J Radiol. 2015 Dec;84(12):2501-8. doi: 10.1016/j.ejrad.2015.09.019.</p> <p>*Key Point: CET and CEDM may be considered as an alternative modality to MRI for following up women with abnormal mammography. All three contrast modalities were superior in accuracy to conventional digital mammography with or without tomosynthesis.</p>	Dec-15	X	X					H
<p>Use of low-energy contrast-enhanced spectral mammography (CESM) as diagnostic mammography-proof of concept</p> <p>K.S. Blum, G. Antoch, S. Mohrmann, S. Obenauer - Radiography, Vol. 21, Issue 4, Nov. 2015, Pages 352-358</p> <p>*Key Point: Data proves the concept of using low-energy CESM image as diagnostic mammography.</p>	Nov-15	X		X				GE
<p>Dual-energy contrast-enhanced spectral mammography (CESM).</p> <p>Daniaux M, De Zordo T, Santner W, Amort B, Koppelstätter F, Jaschke W, Dromain C, Oberaigner W, Hubalek M, Marth C. - Arch Gynecol Obstet. 2015 Oct;292(4):739-47. doi: 10.1007/s00404-015-3693-2. Epub 2015 Mar 27.</p> <p>*Key Point: A review the current literature, present their experience, discuss the advantages and drawbacks of CESM and look at the future of this innovative technique.</p>	Oct-15	X						GE

	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Contrast enhanced digital mammography: Is it useful in detecting lesions in edematous breast?</p> <p>Noha Abd ElShafy ElSaid, Samah Farouk, Ola Magdy Mohamed Shetat, Nagat Mansour Khalifa, Omnia Mokhtar Nada - The Egyptian Journal of Radiology and Nuclear Medicine, Volume 46, Issue 3, Sept 2015, Pages 811-819</p> <p>*Key Point: Dual-energy contrast-enhanced digital mammography is a useful technique in identification of lesions in mammographically dense edematous breasts and proved to be a useful tool in the follow-up of cases presenting by edema after conservative breast surgery and chemotherapy.</p>	Sep-15	X				X	X	GE
<p>Contrast-enhanced spectral mammography: Impact of the qualitative morphology descriptors on the diagnosis of breast lesions</p> <p>Kamal RM, Helal MH, Wessam R, Mansour SM, Godda I, Alieldin N - European Journal of Radiology, Volume 84, Issue 6, June 2015, Pages 1049-1055</p> <p>*Key Point: The assessment of the morphology and enhancement characteristics of breast lesions on CESM enhances the performance of digital mammography in the differentiation between benign and malignant breast lesions.</p>	Jun-15	X			X		X	GE
<p>Contrast-enhanced spectral mammography (CESM) and contrast enhanced MRI (CEMRI): Patient preferences and tolerance.</p> <p>Hobbs MM, Taylor DB, Buzynski S, Peake RE. - J Med Imaging Radiat Oncol. 2015 Jun;59(3):300-5. doi: 10.1111/1754-9485.12296. Epub 2015 Apr 21.</p> <p>*Key Point: Data suggest that overall, patients prefer the experience of CESM to CEMRI, thus adding support for the role of CESM as a possible alternative to CEMRI for breast cancer staging.</p>	Jun-15	X	X		X		X	GE
<p>Comparison between breast MRI and contrast-enhanced spectral mammography.</p> <p>Łuczynańska E, Heinze-Paluchowska S, Hendrick E, Dyczek S, Ryś J, Herman K, Blecharz P, Jakubowicz J. - Med Sci Monit. 2015 May 12;21:1358-67. doi: 10.12659/MSM.893018.</p> <p>*Key Point: The results indicate that CESM has the potential to be a valuable diagnostic method which enables accurate detection of malignant breast lesions, has high negative predictive value, and a false-positive rate similar to that of breast MRI.</p>	May-15	X	X		X		X	GE
<p>The quality of tumor size assessment by contrast-enhanced spectral mammography and the benefit of additional breast MRI.</p> <p>Lobbes MB, Lalji UC, Nelemans PJ, Houben I, Smidt ML, Heuts E de Vries B, Wildberger JE, Beets-Tan RG. - J Cancer. 2015 Jan 5;6(2):144-50. doi: 10.7150/jca.10705. eCollection 2015.</p> <p>*Key Point: Quality of tumor size measurement using CESM is good and matches the quality of these measurement assessed by breast MRI. Additional measurements using breast MRI did not improve the quality of tumor size measurements.</p>	Jan-15		X		X			GE

	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Use of Contrast-Enhanced Spectral Mammography for Intramammary Cancer Staging: Preliminary Results</p> <p>Blum K, Rubbert C, Mathys B, Antoch G, Mohrmann S, Obenauer S - Academic Radiology, Volume 21, Issue 11, November 2014, Pages 1363-1369</p> <p>*Key Point: CESM is accurate in size measurements of small breast tumors. CESM seems to be helpful in the characterization of breast tissue around microcalcifications.</p>	Nov-14	X			X			GE
<p>Dual-energy contrast-enhanced mammography</p> <p>M.M. Travieso Aja, M. Rodríguez Rodríguez, S. Alayón Hernández, V. Vega Benítez, O.P. Luzardo - Radiología (English Edition), Vol 56, Issue 5, Sept–Oct 2014, Pages 390-399</p> <p>*Key Point: Dual-energy contrast-enhanced mammography is a new, apparently promising technique in breast cancer that provides information about the degree of vascularization of the lesion in addition to the morphological information provided by conventional mammography.</p>	Oct-14	X			X	X		GE
<p>Can contrast enhanced mammography solve the problem of dense breast lesions?</p> <p>Mokhtar O, Mahmoud S - The Egyptian Journal of Radiology and Nuclear Medicine, Volume 45, Issue 3, September 2014, Pages 1043-1052</p> <p>*Key Point: Initial clinical results show that CEDM has better diagnostic accuracy than mammography alone and mammography + ultrasound especially in dense breasts.</p>	Sep-14	X			X			GE
<p>Low energy mammogram obtained in contrast-enhanced digital mammography (CEDM) is comparable to routine full-field digital mammography (FFDM)</p> <p>Francescone M, Jochelson M, Dershaw D, Sung J, Hughes MC, Zheng J, Moskowitz C, Morris EA - European Journal of Radiology, Volume 83, Issue 8, August 2014, Pages 1350-1355</p> <p>*Key Point: Low energy CEDM images are equivalent to standard FFDM despite the presence of intravenous iodinated contrast. Low energy CEDM images may be used for interpretation in place of the FFDM, thereby reducing patient dose.</p>	Aug-14	X		X				GE
<p>Contrast-Enhanced Digital Mammography</p> <p>Maxine Jochelson - Radiologic Clinics of North America, Volume 52, Issue 3, May 2014, Pages 609-616</p> <p>*Key Point: Compared to bMRI, contrast-enhanced dual-energy mammography uses the same capability of vascular enhancement and has been demonstrated to be more sensitive than routine mammography.</p>	May-14	X	X					GE



Contrast Enhanced Mammography

(CE2D/CEDM) Selected Bibliography

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	Date	Diagnostic	MRI comparison	Dose	Outcomes	Economics	Cancer Detection	Manufacturer
<p>Dual-energy contrast-enhanced digital mammography: Examination protocol F.R. Barra, A.C. Ribeiro, O.D. Mathieu, A.C. Rodrigues - Diagnostic and Interventional Imaging, Volume 95, Issue 3, March 2014, Pages 351-352 *Key Point: Authors having been utilizing CEDM since 2013 and have developed an examination protocol.</p>	Mar-14	X						n/a
<p>Beyond Mammography: New Frontiers in Breast Cancer Screening Drukteinis JS, Mooney BP, Flowers CI, Gatenby RA - The American Journal of Medicine, Volume 126, Issue 6, June 2013, Pages 472-479 *Key Point: The authors propose that optimal breast cancer screening will eventually require a personalized approach based on metrics of cancer risk with selective application of specific screening technologies best suited to the individual's age, risk, and breast density.</p>	Jun-13	X		X	X	X		
<p>Initial Clinical Experience with Contrast-Enhanced Digital Breast Tomosynthesis Chen SC, Carton AK, Albert M, Conant EF, Schnall MD, Maidment AD - Academic Radiology;14(2), February 2007, Pages 229-238 *Key Point: As an adjunct to digital mammography, CE-DBT may be a potential alternative tool for breast lesion morphologic and vascular characterization.</p>	Feb-07	X						GE
<p>Contrast-Enhanced Digital Mammography John Lewin - Seminars in Breast Disease, Volume 9, Issue 3, September 2006, Pages 105-110 *Key Point: Results from three pilot studies have been promising, with high sensitivity to cancer; however, much work remains before the technique becomes a viable clinical tool.</p>	Sep-06	X						H
<p>MISC-02893 Rev. 009 (06/19) US/International © 2019 Hologic, Inc. All rights reserved. Printed in USA. Subject to change without notice. This is a bibliography of select publications. A search was performed on 01/30/19 using PubMed with the search criteria of "Contrast Mammography". From this list, articles were selected based on the use of Hologic equipment in the discussed study. These are not meant to be claims and are not intended as a product solicitation or promotion where such activities are prohibited. For specific information on what products are available for sale in a particular country, please contact your local Hologic representative or at www.hologic.com.</p>								