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Commentary

The role of MRI in detecting and characterizing brain metastases from breast cancer

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MRI as a Window into Breast Cancer Brain Metastases: A Summary of Recent Evidence

Brain metastases are a feared complication of breast cancer, occurring in 15-25% of patients and being associated with poor prognosis and reduced quality of life [1,2]. Magnetic resonance imaging (MRI) is an advanced technique that uses powerful magnetic fields and radio waves to produce detailed three-dimensional (3D) images of the brain's neuroanatomy and any potential pathology, especially in the management of brain metastases [3-5]. The review article by Mohammadi et al. provides a timely and comprehensive overview of the utility of MRI for detecting and characterizing brain metastases from breast cancer [5].

The authors performed a systematic review of 24 studies from 2000-2023 that examined MRI findings in 1580 breast cancer patients with brain metastases [5]. They found MRI to be highly useful for identifying, visualizing, and monitoring brain metastases through techniques like T1-weighted, T2-weighted, contrast-enhanced, diffusion-weighted, and perfusion imaging. Key findings were that brain metastases tended to occur in the cerebral hemispheres and have an irregular shape and variable contrast enhancement patterns. Advanced MRI methods like diffusion tensor imaging (DTI) and magnetic resonance spectroscopy (MRS) provided additional insights into the metabolism and microstructure of lesions [5-7].

This review highlights several important roles for MRI in managing brain metastases from breast cancer. First, MRI is more sensitive than CT for detecting small and morphologically complex lesions. This allows earlier diagnosis and treatment before lesions become debilitating. Second, MRI provides superior characterization of metastases versus primary brain tumors like glioblastoma. Enhancing patterns, edema, hemorrhage, and necrosis can distinguish pathologies. Third, MRI enables monitoring of treatment response through changes in size, blood flow, and metabolism. However, debate continues over which specific MRI markers are most accurate for distinguishing true progression from pseudoprogression following treatment. Some studies suggest enhancing tumor volume [8-10] is optimal, while others argue that perfusion or diffusion metrics [11-13] are more predictive. Further research is needed to clarify the strengths and limitations of particular MRI biomarkers in this context.

The authors rightly note limitations of the heterogeneity across included studies and the need to validate emerging MRI techniques in larger samples. However, the review collectively reinforces MRI as the preferred modality for imaging brain metastases from breast cancer. MRI surpasses CT in diagnostic sensitivity and specificity. Meanwhile, new methods like diffusion imaging, perfusion imaging, and MR spectroscopy open up possibilities for improving tumor characterization, treatment planning, and prognostication.

An important next step for research in this area is to correlate advanced MRI findings with tumor biology and genetics. Breast cancer subtypes defined by receptors like HER2 and genomic signatures influence metastatic behavior. MRI phenotypes may align with and provide insight into the underlying cancer biology. Studies should also examine how MRI metrics of brain metastases correlate with and potentially predict clinical outcomes like survival and neurocognitive function.

In summary, this review affirms the indispensable role of MRI in managing brain metastases from breast cancer. MRI detects lesions missed by other modalities and offers diverse techniques for visualizing tumor morphology, microenvironment, and metabolism [14-16]. Ongoing research should further optimize MRI acquisition and analysis protocols to make information actionable for prognosis and personalized therapy. MRI is positioned to have tremendous impact for a devastating complication of breast cancer.

Key Messages From Our Systematic Review On Brain Metastases From Breast Cancer Using MRI

- The most common locations for metastases were the cerebral hemispheres, frontal lobe, cerebellum, and ventricles.
- MRI findings varied based on the MRI technique, breast cancer subtype, lesion size/shape, presence of hemorrhage/necrosis, and comparison to other brain tumors.
- Quantitative MRI metrics were associated with prognosis, recurrence risk, and cognitive impairment.
- MRI allows detection, characterization, and monitoring of brain metastases through assessing size, shape, location, composition, perfusion, metabolism, and connectivity.
- Specific MRI techniques can differentiate brain metastases from primary brain tumors and ischemic lesions.
- MRI findings differ based on breast cancer subtype [HER2+ vs triple negative].
- Larger metastases tend to have more hemorrhage/necrosis than smaller ones.
- Advanced MRI techniques can predict outcomes like recurrence and treatment response.
- More research is needed to validate emerging MRI techniques and determine clinical impact of MRI findings on patient management.

Author Contribution

SM and SG contributed to the article and approved the submitted version.

Conflict of Interest

The authors declare no financial or other conflicts of interest.

Ethical Statement

No human or animal subjects were used in the research.

References

1. Custodio-Santos T, Videira M, Brito MA. Brain metastasization of breast cancer. Biochimica et Biophysica Acta [BBA]-Reviews on Cancer. 2017 Aug 1;1868[1]:132-47.
2. Saha A, Ghosh S, Roy C, Choudhury K, Chakrabarty B, Sarkar R. Demographic and clinical profile of patients with brain metastases: A retrospective study. Asian Journal of Neurosurgery. 2013 Sep;8[03]:157-61.
3. Ghaderi S. Fractal Dimension Image Processing for Feature Extraction and Morphological Analysis: Gd 3+/13X/DOX/FA MRI Nanocomposite. Journal of Nanomaterials. 2023 Apr 21;2023:e8564161.
4. Ghaderi S, Ghaderi K, Ghaznavi H. Using marker-controlled watershed transform to detect baker's cyst in MRI images: a pilot Study. J Med Signals Sens. 2022;12[1]:84-9.
5. Mohammadi M, Mohammadi S, Hadizadeh H, Olfati M, Moradi F, Tanzifi G, et al. Brain metastases from breast cancer using magnetic resonance imaging: A systematic review. Journal of Medical Radiation Sciences. 2023 Aug 10.
6. Ghaderi S, Karami A, Ghalyanchi-Langeroudi A, Abdi N, Jalali SS, Rezaei M ,et al. MRI findings in movement disorders and associated sleep disturbances. American Journal of Nuclear Medicine and Molecular Imaging. 2023;13[3]:77.
7. Ghaderi S, Mohammadi S, Heidari M, Sharif Jalali SS, Mohammadi M. Post-COVID-19 vaccination CNS magnetic resonance imaging findings: A systematic review. Canadian Journal of Infectious Diseases and Medical Microbiology. 2023 Jun 29;2023:e1570830.
8. Ramos A, Giantini-Larsen A, Pannullo SC, Brandmaier A, Knisely J, Magge R, et al. A multidisciplinary management algorithm for brain metastases. Neuro-Oncology Advances. 2022 Jan 1;4[1]:vdac176.
9. Ellingson BM, Bendszus M, Sorensen AG, Pope WB. Emerging techniques and technologies in brain tumor imaging. Neuro-Oncology. 2014 Oct 1;16[suppl_7]:vii12-23.
10. Wyatt EA, Davis ME. Method of establishing breast cancer brain metastases affects brain uptake and efficacy of targeted, therapeutic nanoparticles. Bioengineering & Translational Medicine. 2019 Jan;4[1]:30-7.
11. Ahn SJ, Park M, Bang S, Cho E, Ahn SG, Suh SH, et al. Apparent diffusion coefficient histogram in breast cancer brain metastases may predict their biological subtype and progression. Scientific Reports. 2018 Jul 2;8[1]:9947.
12. Guo L, Wang G, Feng Y, Yu T, Guo Y, Bai X, et al. Diffusion and perfusion weighted magnetic resonance imaging for tumor volume definition in radiotherapy of brain tumors. Radiation Oncology. 2016 Dec;11[1]:123.
13. Kessler AT, Bhatt AA. Brain tumour post-treatment imaging and treatment-related complications. Insights into Imaging. 2018 Dec;9[6]:1057-75.
14. Chhetri A, Li X, Rispoli JV. Current and emerging magnetic resonance-based techniques for breast cancer. Frontiers in Medicine. 2020 May 12;7:175.
15. Bai JW, Qiu SQ, Zhang GJ. Molecular and functional imaging in cancer-targeted therapy: Current applications and future directions. Signal Transduction and Targeted Therapy. 2023 Feb 27;8[1]:1-32.
16. Cyran CC, Paprottka PM, Eisenblätter M, Clevert DA, Rist C, Nikolaou K, et al. Visualization, imaging and new preclinical diagnostics in radiation oncology. Radiation Oncology. 2014 Dec;9[1]:3.