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Review article

# Synthetic MRI- A new approach of segmentation

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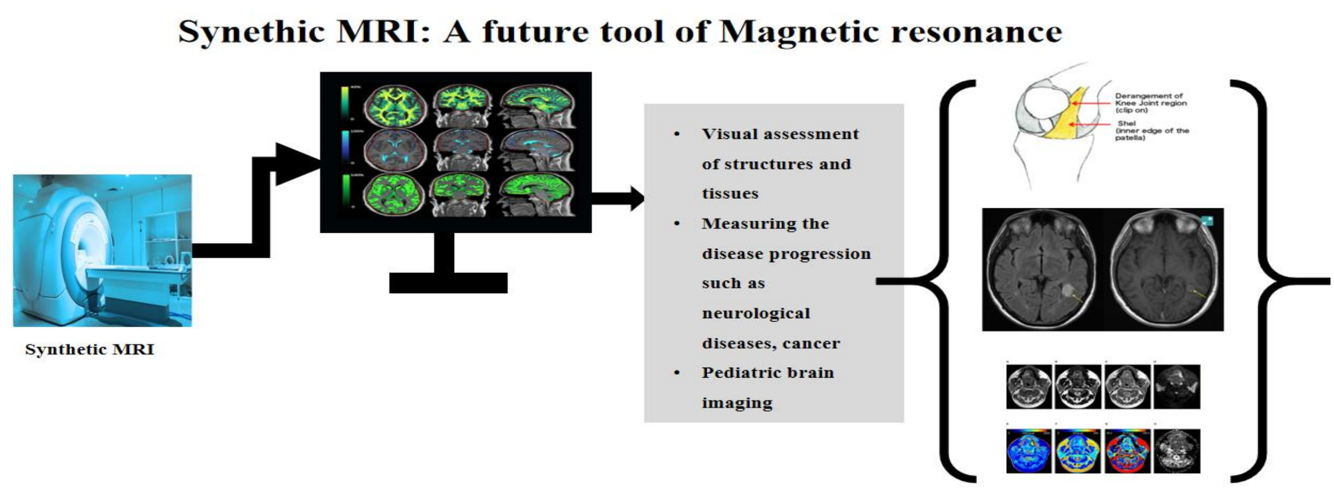
## ABSTRACT

Synthetic MRI is a novel technology which aids in the transition from diagnosis based on tissue contrast to intrinsic tissue characteristics. Quantitative information can be helpful in verifying visual assessments of structures and tissues against a normal quantitative standard**.** With Synthetic MRI, we get new opportunities to monitor and measure disease progression using quantifiable data and to get more information in one third of the time. Synthetic MRI aims at evaluating the value of quantitative MR parameters in the most accurate manner. The ability to quickly quantify the data while also generating several contrast-weighted images will speed up the workflow while at the same time providing clinically relevant data to the patients. With objective measurements and reference curves provided by Synthetic MRI, the diagnostic confidence can be increased.

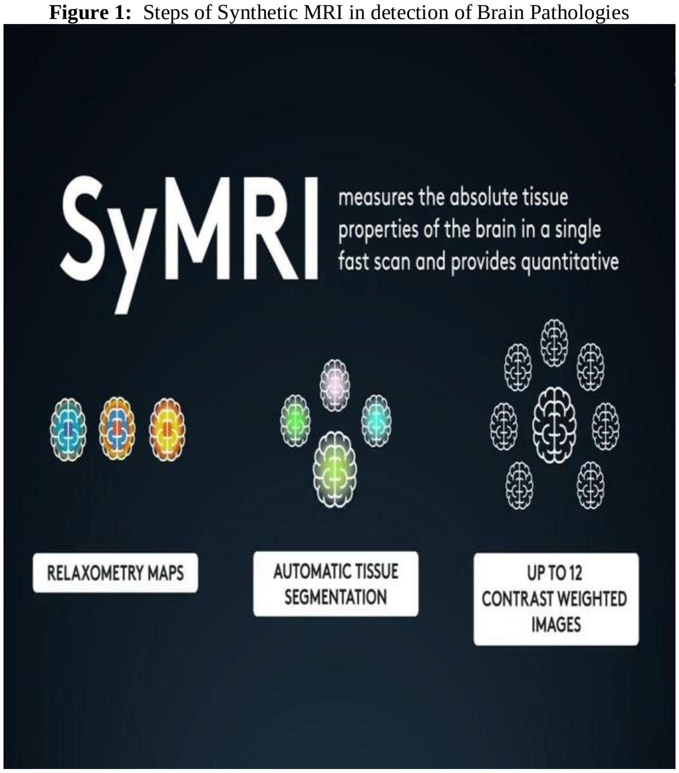



**Keywords:** SyMRI, Multidelay, Multiecho, Fast spin echo, Multiple Sclerosis

## INTRODUCTION

Synthetic Magnetic Resonance Imaging (SyMRI) is the widely accepted pinpoint technique over the normal MRI in this developing era of technology and medical field. SyMRI is a technique that synthesises contrast-weighted images from multicontrast MRI data **[1].** SyMRI's unique technology supports a faster MR imaging workflow and allows users to follow disease progression and therapy efficacy with greater confidence. SyMRI is a novel imaging technique that allows generating multiple contrast-weighted images based on relaxivity measurements of tissue properties in a single acquisition using a multiecho, multidelay saturation recovery spin-echo sequence **[2].**

**Figure 1:** Steps of Synthetic MRI in detection of Brain Pathologies




SyMRI is a low cost procedure that serves as a bridge between qualitative and quantitative MRI [3].However, the suggested methods require distinct sequences or privatized protocols which have rarely found its unification in clinical scanners. SyMRI also proved to be a boon for pediatric brain pathology diagnosis (Figure 1). Use of SyMRI may overcome the limitations of conventional MRI in pediatric brain imaging [4].

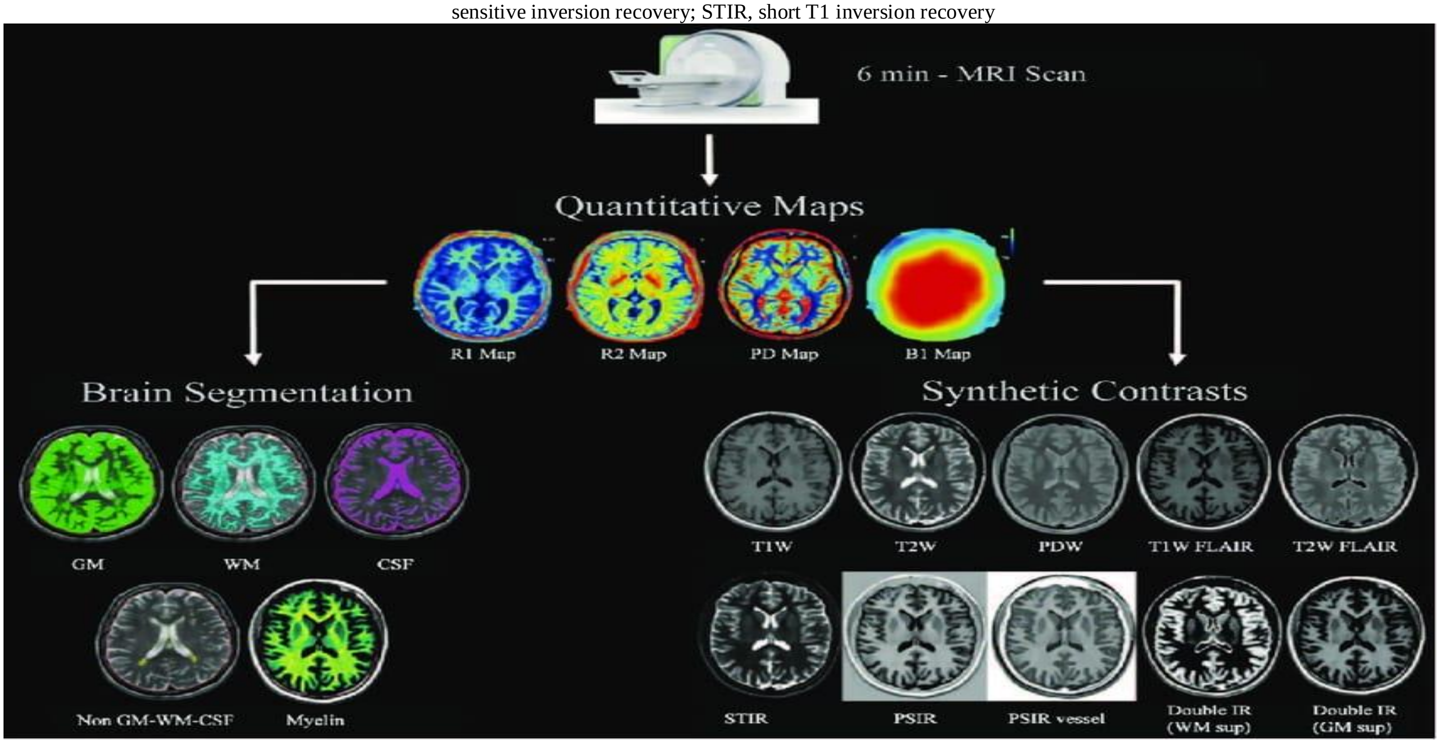
**Technical Parameters**

The technical parameters used in SyMRI for various cases is as follows:

**For Neurological Diseases (Brain Tumor, Epilepsy, Multiple Sclerosis or Stroke)**

3T/Conventional contrast-weighted imaging (T1/T2 weighted, proton density [PD] weighted, and fluid-attenuated inversion recovery [FLAIR]) and a Magnetic Resonance Spin Tomography in Time-domain (MR-STAT) acquisition (2D Cartesian spoiled gradient echo with varying flip angle preceded by a non-selective inversion pulse) and Quantitative T1, T2 and PD maps were computed from the MR-STAT acquisition, from which synthetic contrasts were generated [5] (Figure 2).

**Figure 2:** Representation of the process of synthetic imaging acquisition and post processed synthetic contrast images and segmented volumes. PSIR indicates phase-sensitive inversion recovery; STIR, short T1 inversion recovery




**For Breast Cancer**

In this, the regular MR imaging protocol included axial iterative decomposition of water and fat with echo asymmetry and least square estimation T2-weighted imaging (IDEAL-T2WI), axial fast spin-echo (FSE) T1WI, axial diffusion-weighted imaging (DWI), sagittal inversion recovery T2WI in both breast and axial three-dimensional (3D) contrast-enhanced VIBRANT-flex SyMRI used as a 2D FSE multidelay, multiecho (MDME) sequence before contrast agent injection, with the following parameters: four automatically calculated saturation delays (inversion times), recovery time (TR)=4000ms, echo time=1 ( TE1)/echo time, 2(TE2)=21/95ms, slice thickness=5mm, interval=1mm, field of view(FOV)=28cm, image matrix=320x256, receiver bandwidth=41.67kHz. The total scan time for SyMRI was 4 min and 30s [6].

**Clinical Applications**

**Generation of Magnetic Resonance Angiography (MRA) images**

MRA generated by deep learning from 3D SyMRI data visualized major intracranial arteries as effectively TOF-MRA, with inherently aligned quantitative maps and multiple contrast-weighted images [7].

**Detection of Brain Metastases**

Synthetic T1IR imaging created better results of contrast compared with synthetic T1W or conventional T1IR imaging. The ability to detect brain metastases was comparable among these imaging [8].

**Detection of Acute Ischemic Stroke**

Synthetic fluid-attenuated inversion recovery (FLAIR) had diagnostic performance similar to real FLAIR in depicting diffusion-weighted imaging-FLAIR mismatch and in helping to identify early acute ischemic stroke and it may accelerate MRI protocols [9].

**Diagnosis of Internal Derangements of the Knee Joint**

Conventional and Synthetic MRI showed substantial to almost perfect degree of agreement for the assessment of internal derangement of knee joints [10] (Figure 3).

**Figure 3:** Quantitative Mapping of knee joint MRI

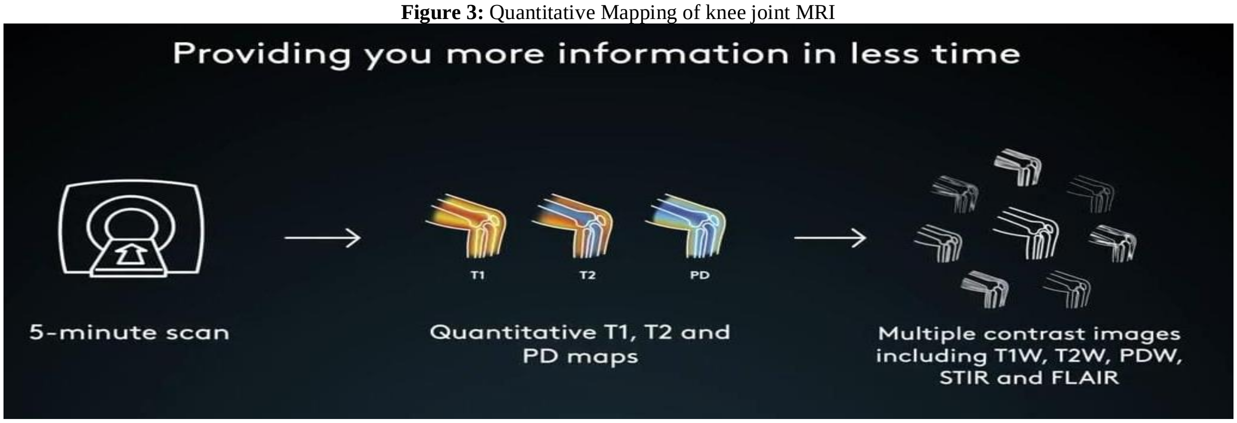
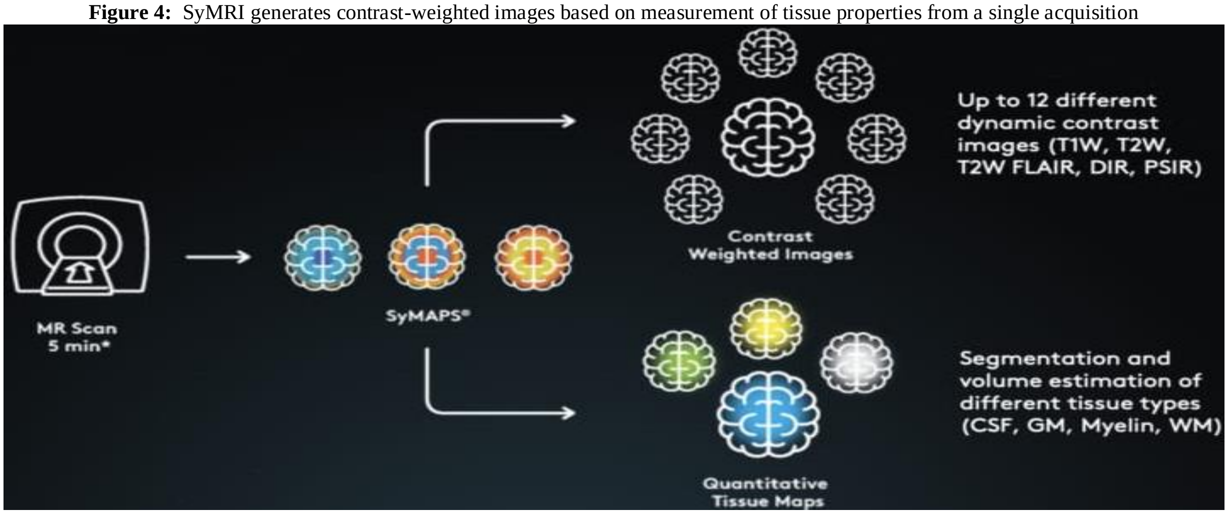



**Figure 4:** SyMRI generates contrast-weighted images based on measurement of tissue properties from a single acquisition




**For Myelin Measurement**

Myelin loss is observed in both normal-appearing white matter (NAWM) and white matter hyperintensities (WMHs) of cognitively impaired patients. SyMRI-based myelin quantification may be a useful imaging marker of cognitive dysfunction in patients with cognitive complaints [11]. Gadolinium is the best contrast for such studies (Figure 4).

**Detection of Multiple Sclerosis Plaque**

SyMRI turned out to be the most useful technique in the detection of more multiple sclerosis (MS) plaques. The contrast for MS plaques in Synthetic double inversion recovery images was better than on conventional double inversion recovery images [12].

SyMRI's also provide a distinct tissue relaxation time enabling a more accurate estimation of ischemic stroke status [13]. The T1 and T2 metrics in SyMRI could be potential surrogate biomarkers for Brain Metastases [BM] free water content (cellularity) and tumor morphology respectively [14]. It plays a vital role in diagnosis of knee joint derangement. Gadolinium had a significant effect on the automatic calculations of myelin and brain tissue volumes using quantitative SyMRI, which can be explained by decreases in T1, T2 and proton density [15]. Synthetic MRI can be potentially used as an alternative to conventional brain MRI sequences in the assessment of MS [16].

## CONCLUSION

Synthetic MRI is a technique that generates contrast-weighted images based on measurements of tissue properties from a single acquisition. Synthetic MRI's unique technology measures the absolute properties of the required anatomical region and delivers synthetic contrast-weighted images, tissue segmentations and parametric maps of the patient. Synthetic MRI differ slightly or greatly for variant clinical cases. The sequences, FOV, image matrix, slice thickness, band width etc for cases of neurological diseases are considered different from that of breast cancer cases and other cases. However, Synthetic MRI has found its fascinating use in clinical applications such as for generation of MRA images, for detection of brain metastases, for detection of acute ischemic stroke, for diagnosis of the internal derangements of the knee joint, for myelin measurement, for detection of Multiple Sclerosis plaque. The MR Angiography images obtained from Synthetic MRI helps in better visualizing intracranial arteries effectively.

## REFERENCES


1. JI S, Yang D, Lee Jet al, 2022. Synthetic MRI: Technologies and Applications in Neuroradiology. Journal Magn Reson Imaging. 55(4), Pages 1013-1025. Doi: 10.1002/jmri.27440.
2. Gonçalves FG, Serai SD, Zuccoli G, 2018. Synthetic Brain MRI: Review of Current Concepts and Future Directions. Top Magn Reson Imaging. 27(6), Pages 387-393. Doi: 10.1097/RMR.0000000000000189.
3. Moya-Sáez E, Peña-Nogales Ó, Luis-García R, et al, 2021. A deep learning approach for synthetic MRI based on two routine sequences and training with synthetic data. Comput Methods Programs Biomed. 210, Pages 106371. Doi: 10.1016/j.cmpb.2021.106371.
4. Andica C, Hagiwara A, Hori M, et al, 2019. Review of synthetic MRI in pediatric brains: Basic principle of MR quantification, its features, clinical applications, and limitations. Journal Neuroradiol. 46(4), Pages 268-275. Doi: 10.1016/j.neurad.2019.02.005.
5. Kleinloog JPD, Mandija S, D'Agata F, et al, 2022. Synthetic MRI with Magnetic Resonance Spin TomogrAphy in Time-Domain (MR-STAT): Results from a Prospective Cross-Sectional Clinical Trial. Journal Magn Reson Imaging. 57(5), Pages 1451-1461. Doi: 10.1002/jmri.28425.
6. Meng T, He N, He H, et al, 2020. The diagnostic performance of quantitative mapping in breast cancer patients: a preliminary study using synthetic MRI. Cancer Imaging. Doi: 10.1186/s40644-020-00365-4.
7. Fujita S, Hagiwara A, Otsuka Y, et al, 2020. Deep Learning Approach for Generating MRA Images From 3D Quantitative Synthetic MRI Without Additional Scans. Invest Radiol. 55(4), Pages 249-256. Doi: 10.1097/RLI.0000000000000628.
8. Hagiwara A, Hori M, Suzuki M, 2016. Contrast-enhanced synthetic MRI for the detection of brain metastases. Acta Radiol Open. 5(2), Pages 2058460115626757. Doi: 10.1177/2058460115626757.
9. Benzakoun J, Deslys MA, Legrand L, et al, 2022. Synthetic FLAIR as a Substitute for FLAIR Sequence in Acute Ischemic Stroke. Radiology. 303(1):153-159. Doi: 10.1148 /radiol.211394.
10. Yi J, Lee YH, Song HT, et al, 2018. Clinical Feasibility of Synthetic Magnetic Resonance Imaging in the Diagnosis of Internal Derangements of the Knee. Korean Journal Radiol. Doi: 10.3348/kjr.2018.19.2.311.
11. Park M, Moon Y, Han SH, et al, 2019. Myelin loss in white matter hyperintensities and normal-appearing white matter of cognitively impaired patients: a quantitative synthetic magnetic resonance imaging study. Eur Radiol. 29(9), Pages 4914-4921. Doi: 10.1007/s00330-018-5836-x.
12. Hagiwara A, Hori M, Yokoyama K, et al, 2016. Synthetic MRI in the Detection of Multiple Sclerosis Plaques. AJNR Am Journal Neuroradiol. 38(2), Pages 257-263. Doi: 10.3174/ajnr.A5012.
13. Li CW, Hsu AL, Huang CC, et al, 2020. Reliability of Synthetic Brain MRI for Assessment of Ischemic Stroke with Phantom Validation of a Relaxation Time Determination Method. Journal Clin Med. 9(6), Pages 1857. Doi: 10.3390/jcm9061857.
14. Konar AS Shah, AD Paudyal, R. Fung, et al, 2022. Quantitative Synthetic Magnetic Resonance Imaging for Brain Metastases: A Feasibility Study.Cancers 14, Pages 2651. Doi: https:// doi.org/10.3390/cancers14112651.
15. Maekawa T, Hagiwara A, Hori M, et al, Effect of Gadolinium on the Estimation of Myelin and Brain Tissue Volumes Based on Quantitative Synthetic MRI. AJNR Am Journal Neuroradiol. 2019 40(2), Pages 231-237. Doi: 10.3174/ajnr.A5921.
16. Aymerich FX, Auger C, Alonso Journal, et al, 2022.Assessment of 2D conventional and synthetic MRI in multiple sclerosis. Neuroradiology. 64(12), Pages 2315-2322. Doi: 10.1007/s00234-022-02973-2.