Original Research Article

Comparison of quality of images performed with and without magnetisation transfer contrast in magnetic resonance imaging

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Abstract

Background: Magnetization transfer contrast (MTC) is most useful in improving image contrast and tissue characterization. It has also proven to be extremely useful in the reduction of background signal in MR angiography and improves the appreciation of tissue enhancement by intravenous contrast agents. **Aim:** To compare the quality of images performed with and without magnetisation transfer contrast in magnetic resonance imaging. **Material and Methods:** Magnetic Resonance Imaging of Central Nervous System was performed on a clinical 1.5 Tesla MRI system employing standardized protocol. Plain Brain and 3D Time of flight MR Angiography was performed without and with application of Magnetic Transfer preparation pulse. **Results:** Relative difference in tissue contrast was seen between images acquired without and with MTC. The magnitude of the tissue signals acquired with MTC showed significant improvement by a minimum of 1% to a maximum of 92% in this group of patients. The mean percentage of tissue signal magnitude was 41%. **Conclusion:** Magnetization Transfer Contrast plays a pivotal role in magnetic resonance imaging of Central nervous system by improving image contrast and tissue characterization and therefore, should form a part of the routine diagnostic imaging protocol.
Key Words: Magnetization Transfer Contrast, Magnetic Resonance, Central Nervous System, Image quality.

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INTRODUCTION

Magnetization transfer contrast (MTC) is a unique contrast mechanism in magnetic resonance (MR) imaging that has been known for the past decade. The Technique of Magnetization Transfer (MT) use a pulse of pre-saturation with the aim to modify the relaxation times of macro and free protons of the water witch that have low molecular mobility. The protons mainly saturated are attached to macromolecules. This phenomenon may also occur in some protons from tissues of the free water with effective MT.[1,2] Thus, the combination of this technique with T1 sequences after gadolinium administration, may show an additional enhancement and detection capability of lesions not detected on conventional T1-weighted images in the same conditions.[3,4] Magnetization transfer contrast (MTC) is most useful in two basic areas, improving image contrast and tissue characterization. It has also proven to be extremely useful in the reduction of background signal in MR angiography and improves the appreciation of tissue enhancement by intravenous contrast agents. Today MT is accepted as an additional way to generate unique contrast in MRI that can be used to our advantage in a variety of clinical applications. This study was conducted to compare the quality of images performed with and without magnetisation transfer contrast in magnetic resonance imaging.

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MATERIAL AND METHODS

This prospective study was conducted at Department of Radiology and Imaging Sciences, Sri Ramachandra Hospital. A population of 38 patients of either sex who presented themselves in Radiology department whose reports and image data were collected retrospectively during the study period.

Inclusion Criteria

- All patients undergoing MRI Brain

Exclusion Criteria

- First trimester pregnancy
- Unco-operative patients
- Claustrophobic patients

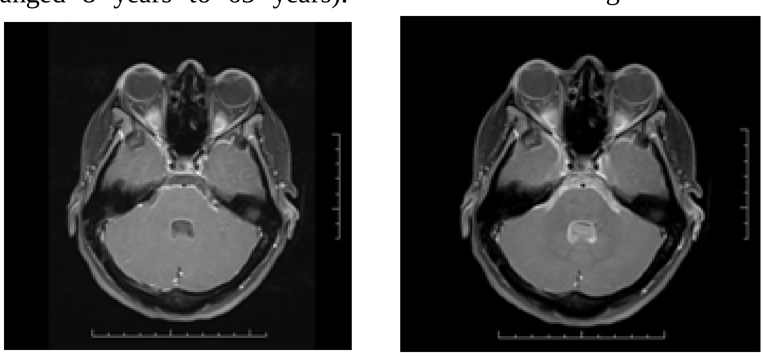
Magnetic Resonance Imaging of Central Nervous System was performed on a clinical 1.5 Tesla MRI system employing standardized protocol. Plain Brain and 3D Time of flight MR Angiography was performed without and with application of Magnetic Transfer preparation pulse. Subsequently post processing was done to calculate Magnetic Transfer Contrast values, mean, standard deviation and area measurements. The values were tabulated and analyzed.

RESULTS

Table 1: Values of MRA brain studies without MTC and with MTC pulse

Sr. No.	Without MTC Mean	SD	Area (cm^2)	With MTC Mean	SD	Area (cm^2)
01	123.5	22.8	0.13	158.5	33.9	0.13
02	510.3	615	0.10	572.3	151.1	0.10
03	460.5	9.7	0.10	432.1	30.2	0.10
04	440.2	35.6	0.15	452.0	46.7	0.15
05	521.8	124.4	0.9	579.9	88.2	0.9
06	168.0	45.5	0.05	197.9	31.9	0.05
07	607.5	55.2	0.08	827.2	182.3	0.08
08	620.1	17.8	0.06	708.5	94.5	0.06

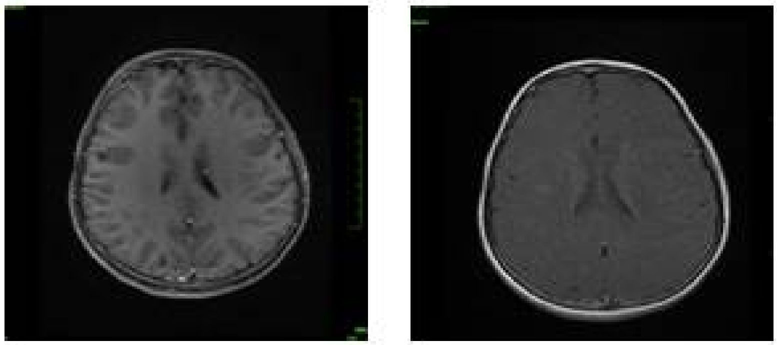
This study included 38 patients of which 21 were male and 17 female patients. The mean duration of these patients was 40 years (ranged 8 years to 65 years). Magnetic resonance imaging scan without and with Magnetization transfer preparation pulse application was performed for all the 38 patients. 10 out of 38 patients underwent plain magnetic resonance imaging Brain studies, 20 patients underwent Gadolinium enhanced Magnetic Resonance Imaging Brain studies and 8 patients underwent 3D Time of flight Magnetic Resonance Angiography of the Brain. 10 patients who underwent plain Magnetic Resonance Imaging Brain studies revealed variable findings. Simple T1 weighted Spin Echo images were acquired without and with magnetic transfer contrast preparation pulses. The magnitude of the tissue signals of the two sets of images without and with magnetic transfer Contrast shows relative differences. The tissue contrast was better on images acquired with Magnetic Transfer Contrast. The magnitude of tissue acquired with Magnetic Transfer Contrast was increased by a minimum of 7.6% to a maximum of 45% in this group of patients. The mean percentage of signal magnitude was 24.6%. Standard deviation ranged between 10.9 and 225.5. 20 patients who underwent Gadolinium enhanced Magnetic Resonance Brain studies revealed significant findings which were variable. Post contrast T1 weighted Spin Echo images were acquired without and with Magnetization Transfer Contrast preparation pulse. Images acquired with magnetization transfer contrast showed improved tissue contrast achieved by suppressing signals from background tissues. Relative difference in tissue contrast was seen between images acquired without and with magnetization transfer contrast. The magnitude of the tissue signals acquired with Magnetization Transfer Contrast showed significant improvement by a minimum of 1% to a maximum of 92% in this group of patients. The mean percentage of tissue signal magnitude was 41%. Standard deviation ranged between 16.8 and 459.9. Gadolinium enhanced magnetic resonance imaging with magnetization transfer contrast of one patient with history of development delay suggested possibility of demyelination. Two patients on anti-tuberculous treatment showed features favouring tuberculousmeningitis.



Without MTC **With MTC**

Figure 1: Images of Tuberculous meningitis without and with Magnetic Transfer Contrast pulse

Follow up Magnetic Transfer Contrast of one patient is revealed multiple small enhancing lesion not seen on earlier MRI suggestive of demyelination. Magnetic Resonance Imaging of one patient showed granulomatous lesion with edema, features which were suggestive of Tuberculoma. Magnetic Resonance Imaging features of one patient was suggestive of Acute disseminated encephalomyelitis (ADEM).



Without MTC **With MTC**

Figure 2: Images without and with Magnetic Transfer Contrast pulse demonstrating acute disseminated encephalomyelitis

The Magnetic Resonance Angiogram of all the eight patients revealed no significant abnormalities except for one patient whose Magnetic Resonance Angiogram showed hypoplastic right vertebral artery. By employing magnetic transfer contrast pulses, signal intensity of white and grey matter was reduced. Contrast between Brain tissue and intra cranial arteries and the conspicuity of small vessels was improved with Magnetic Transfer Contrast. The signal intensity of Brain parenchyma was suppressed leaving signal from blood unaffected, thus improving small vessel visibility.

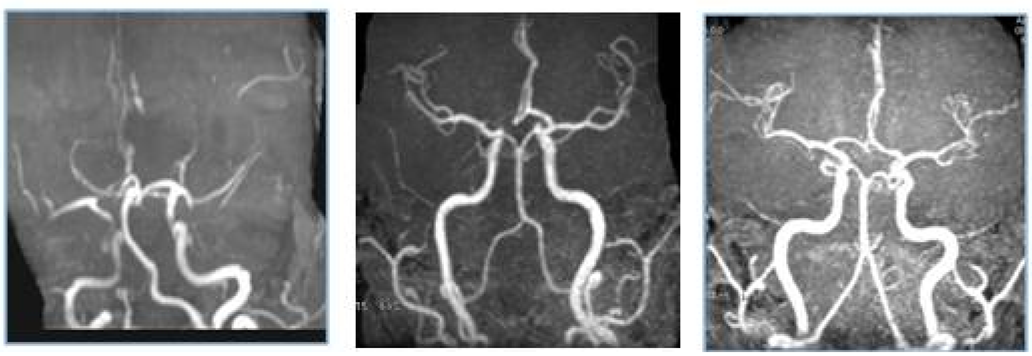


Figure a: **Figure b:** **Figure c:**

Figure d: **Figure e:** **Figure f:**

Figure 3a: Comparison of intracranial 3D Time of flight images acquired without (a to c) and with (d to f) Magnetic Transfer pulse

The magnitude of the signals of intracranial vessels with background suppression increased with magnetic transfer preparation pulses by a minimum of 2.6% and a maximum of 27% in this group of patients. The mean percentage of signal magnitude was 13.3%. Standard deviation ranges between 30.2 and 182.3. It was further observed that the TR increased with application of Magnetic Transfer pulse with increased scan time by 4 minutes and 20% increase in RF energy deposited.

DISCUSSION

The use of MTC in clinical scanning is based on the fact that different biological tissues show different sensitivities for magnetization transfer (MT). Spin Echo post contrast T1-weighted imaging is essential for the diagnosis of Tuberculous meningitis. In this study post contrast Magnetization Transfer Spin Echo imaging has improved the sensitivity of detecting meningitis. Magnetization transfer contrast activated intravenous contrast enhanced T1 weighted Spin Echo images showed improved tissue contrast, thereby, rendering Gadolinium enhanced areas must move conspicuous. Visibility of the lesion on magnetization transfer spin echo images was probably due to the difference in contrast between brain parenchyma and the lesion due to differential transfer of magnetization. Magnetization transfer contrast activated post contrast T1-weighted Spin Echo images can be characterized the CNS infections by improving the detectability of lesions compared to images without magnetization transfer contrast. The fact that MT amplifies the tissue contrast has been reported by many authors, both withon-resonance and off-resonance pulses.[6-9] Mehta reported for example a contrast improvement factor of 1.6 - 2.1 for CNS tumours (metastases, glial tumours, lymphomas) when combining MT with gadolinium-enhanced MR imaging at 1.5 T.[10] In this study Magnetization Transfer Contrast has been found to be extremely useful in the reduction of signal intensity of background tissues in 3D TOF MRA. This enabled an improved contrast between brain parenchyma and intracranial vessels and thereby, improving the conspicuity of small vessels. However, Ribeiro *et al* stated that MT is a technical parameter in MRI which does not produce significant benefits in improving the overall quality of the brain images, however, proved to be very important in the diagnosis of multiple sclerosis, allowing a greater enhancement of demyelinating plaques in the white matter and a better detection of lesions that are not revealed by conventional T1 sequences.[11] A drawback of applying Magnetization Transfer pulse was that it leads to an increased TR resulting in a longer scan time and an increased RF energy deposition. However, use of Magnetization Transfer Contrast pulse can substantially enhance the quantity of 3D Time of flight magnetic transfer angiogram of Brain. This Magnetization Transfer Contrast can be routinely employed to improve small vessel conspicuity.

CONCLUSION

Magnetization Transfer Contrast plays a pivotal role in magnetic resonance imaging of Central nervous system by improving image contrast and tissue characterization and therefore, should form a part of the routine diagnostic imaging protocol.

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