Original Research Article

Significance of magnetic transfer contrast in MR imaging of central nervous systems

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Abstract

Background: Magnetic Transfer Contrastis a useful diagnostic tool in characterization of a variety of central nervous system (CNS) infections. The role of MTC has been studied in the detection and diagnosis of meningitis, encephalitis, CNS tuberculosis, neurocysticercosis, brain abscess and multiple sclerosis. **Aim:** To assess the significance of magnetic transfer contrast in MR imaging of central nervous system. **Material and Methods:** Magnetic Resonance Imaging of CNS was performed on a clinical 1.5 Tesla MRI system employing standardized protocol on 38 patients. Plain Brain and 3D Time of flight MR Angiography was performed without and with application of Magnetic Transfer preparation pulse. **Results:**10 out of 38 patients underwent plain magnetic resonance imaging. The Magnetic Resonance Angiogram of all the eight patients revealed no significant abnormalities except for one patient showed hypoplastic right vertebral artery. By employing magnetic transfer contrast pulses, signal intensity of white and grey matter was reduced. The signal intensity of Brain parenchyma was suppressed leaving signal from blood unaffected, thus improving small vessel visibility. **Conclusion:** MTC 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: Magnetic Transfer Contrast, Magnetic resonance imaging, Brain, Central nervous system.

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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. MTC is most useful in two basic areas, improving image contrast and tissue characterization.[1] 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. Various researchers have studied the utility of MTC in central nervous system pathology and appear to be establishing as a useful diagnostic tool in characterization of a variety of central nervous system (CNS) infections.[2-7] The role of MTC has been studied in the detection and diagnosis of meningitis, encephalitis, CNS tuberculosis, neurocysticercosis, brain abscess and multiple sclerosis. The present study was conducted to assess the significance of magnetic transfer contrast in MR imaging of central nervous system.

MATERIAL AND METHODS

This prospective study was conducted at Department of Radiology and Imaging Sciencesand included 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

1. First trimester pregnancy
2. Unco-operative patients
3. Claustrophobic patients

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MR Safety: All patients for the MRI scan were screened with metal detector before the procedure to avoid complications due to any implants. Possible contra-indications were checked. Metallic jewelries, tattoos, make up, eye shadow etc., were removed prior to MR examinations as it could cause probable RF burns due to high RF absorption locally. The patients were educated about the possibility of an increase in the body temperature, blood pressure and heart rate. Frequent interactions with the patients during the MR examinations were encouraged and continuous contact with them was enabled through squeeze ball.

MRI Brain Protocol: After exclusive MRI screening, patient was positioned head first in supine position. Head was positioned in the Head matrix coil, patient immobilized with pads and Velcro bands.Laser beam localizer was centred over the glabella.

Methodology: 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

This study included 38 patients of which 21 were male and 17 female patients. The mean age of these patients was 40 years (ranged 8 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. Among brain studies, 20 patients underwent Gadolinium enhanced Magnetic Resonance Imaging Brain studies and 8 patients underwent 3 D Time of flight Magnetic Resonance Angiography of the Brain. Of the 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.

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

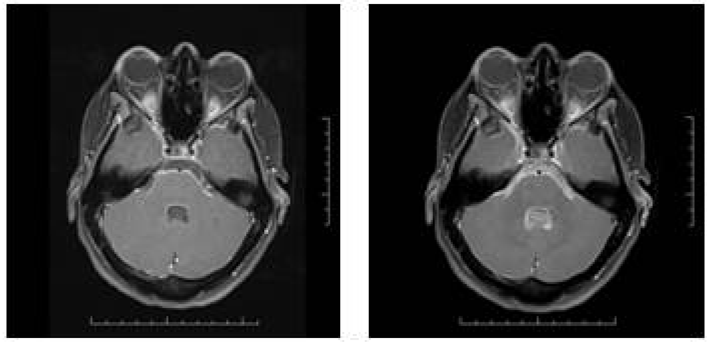
Sr. No.	Without MTC Mean	SD	Area (cm^2)	With MTC Mean	SD	Area (cm^2)
01	479.3	221.0	0.35	673.6	225.5	0.35
02	503.4	12.5	0.12	673.6	10.9	0.12
03	267.8	42.6	0.38	401.7	85.0	0.38
04	497.2	48.3	0.27	757.2	45.1	0.27
05	756.9	44.5	0.23	1376.4	97.1	0.23
06	343.6	23.0	0.22	483.2	42.3	0.22
07	329.9	93.4	0.26	495.0	141.5	0.26
08	523.6	37.0	0.22	548.0	37.3	0.22
09	757.8	40.6	0.22	787.6	64.5	0.22
10	420.3	71.7	0.23	455.1	125.1	0.23

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 MTC preparation pulse. Images acquired with magnetization transfer contrast showed improved tissue contrast achieved by suppressing signals from background tissues.

Table 2: Values of Gadolinium enhanced MRI 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	770.6	204.0	0.46	787.4	166.6	0.46
02	330.0	90.4	0.43	106.5	127.3	0.43
03	1012.3	452.6	0.33	10421.2	454.5	0.33
04	976.8	120.9	0.43	1723.3	250.0	0.43
05	556.0	38.1	0.44	558.7	28.0	0.44
06	232.3	121.3	0.37	733.6	85.3	0.37
07	541.7	36.6	0.48	900.3	66.6	0.48
08	525.1	185.4	0.22	1230.9	242.4	0.22
09	736.6	224.7	0.12	746.3	259.0	0.12
10	244.0	150.1	0.35	675.3	217.2	0.35
11	675.0	12.3	0.12	678.5	16.8	0.12
12	420.7	123.4	0.38	512.1	90.1	0.38
13	982.1	473.4	0.27	1885.3	459.9	0.27
14	972.7	231.9	0.23	2228.5	353.0	0.23
15	444.7	85.7	0.22	541.7	41.5	0.22
16	497.6	40.4	0.26	917.7	237.9	0.26
17	422.2	31.6	0.22	612.2	32.6	0.22
18	531.8	56.5	0.22	1066.7	230.9	0.22
19	567.5	36.6	0.23	627.7	61.7	0.23
20	530.3	88.0	0.30	533.5	35.8	0.30

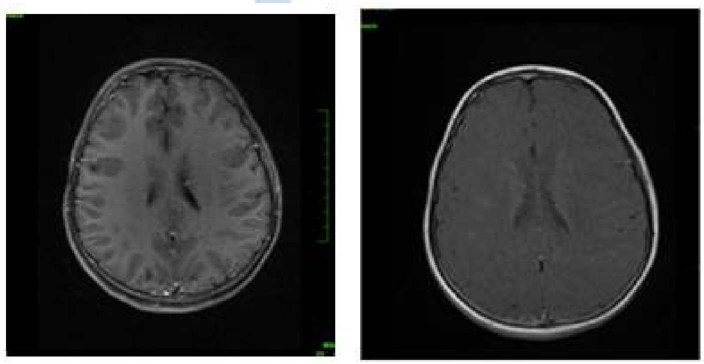
Relative difference in tissue contrast was seen between images acquired without and with magnetization transfer contrast. The magnitude of the tissue signals acquired with Magnetization Transfer Contrast showed significant improvement by a minimum of 1% to a maximum of 92% in this group of patients. 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 favoring tuberculous meningitis (Fig. 1).



(Without MTC) (With MTC)

Figure 1: A case of Tuberculous meningitis without and with MTC pulse

Follow up Magnetic Transfer Contrast of one patient is revealed multiple small enhancing lesion not seen on earlier MRI suggestive of demyelination. One patient's Magnetic Resonance Imaging 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) (Fig. 2).



(Without MTC) (With MTC)

Figure 2: A case of acute disseminated encephalomyelitis without and with MTC pulse

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. 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

Magnetic Transfer Contrast generates unique contrast in magnetic resonance imaging that can be used to our advantage in clinical application. Magnetization Transfer contrast mechanism in magnetic resonance imaging has been found to be most useful in two basic areas, improving image contrast and tissue characterization. The magnitude of the tissue signals with MTC pulse showed relative difference when compared to the magnitude of tissue signal without MTC pulse. Images acquired with MTC pulse showed prominent magnetization transfer saturation of brain parenchyma, most noticeably the white matter, without noticeably influence on Cerebrospinal fliud. It is well documented that MT sequences improve the conspicuity of contrast enhancement by suppressing background tissue signal intensity. This effect has been shown to be both dose related and synergistic.[6,8] Finelli *et al*[9] reported similar relative contrast improvement with triple-dose contrast-enhanced non-MT images compared with single-dose contrast-enhanced images with MT suppression. The synergistic effect is due to the fact that paramagnetic contrast agents decrease the MT effect within enhancing lesions, thereby further accentuating differences between enhancing lesions and background tissues.[8] Therefore, the signal intensity of enhancing lesions is only minimally decreased with 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. A recent study by Mehta *et al*[7] suggested that MT pulses had little effect on noncontrast T1-weighted images in the first 14 patients of their 86-patient series. 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. The role of Magnetization transfer contrast activated magnetic resonance imaging is more specific than Computed tomography in the diagnosis of encephalomyelitis demonstrating characteristic distribution and greater central nervous system involvement. 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.

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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