DOI: https://doi.org/10.53350/pjmhs22168370

ORIGINAL ARTICLE

Differentiating Pyogenic Brain Abscesses and Tuberculous using Magnetization Transfer MR Imaging and in Vivo Proton MR Spectroscopy

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ABSTRACT

Objective: To find whether in vivo proton MR spectroscopy and magnetization transfer (MT) MR imaging can be used to differentiate between tuberculous brain abscess and pyogenic brain abscess.

Study Design: Retrospective

Place and duration: Radiology Department of Ibn_e_Sina Hospital Multan from January 2021 to January 2022.

Methodology: The study included 15 subjects with brain abscesses who underwent in vivo MR spectroscopy, MT MR imaging and conventional MR imaging. Those with other systemic diseases were excluded. These techniques were also performed on 10 sex and age-matched control subjects for comparing MT ratios in normal and diseased parenchymal locations. 13 tuberculous abscesses were found in 4 patients, and 20 pyogenic abscesses were found in 11 patients. MT MR imaging and in vivo MR spectroscopy were used to evaluate suspected brain abscesses.

Results: The mean MT ratio of the pyogenic brain abscesses was 25.55±1.60.MR spectroscopy showed that in pyogenic abscesses level of amino acids (valine, isoleucine, leucine) was 0.8 ppm and lipid and lactate was 1.2 ppm. Additionally, acetate, 1.91 ppm; glycine, 3.55 ppm; succinate,2.40 ppm and alanine, 1.47 pm were also seen. Four patients had 13 tuberculous abscesses. The mean MT ratio obtained from tuberculous abscesses was 19.87±1.54, which was significantly lower compared to the cortical grey matter, deep grey matter, white matter and pyogenic abscess (p<.001).

Conclusion: MT ratios in tuberculous brain abscesses were lower than in pyogenic abscesses. In vivo, MR spectroscopy in pyogenic abscesses did not show amino acids. Tuberculous brain abscess can be differentiated from the pyogenic abscess by using both in vivo MR spectroscopy and MT MR imaging.

Keywords: Pyogenic brain abscess, tuberculous brain abscess, MR spectroscopy

INTRODUCTION

Tuberculous brain abscess is a rare disorder seen in both immunocompetent and immunocompromised individuals[1,2]. For confirming true tuberculous abscess, presence of an abscess in the brain parenchyma, histology confirming vascular granulation tissue in the abscess wall and bacteriologic samples proving tuberculosis is required[3]. Tuberculous brain abscess can be diagnosed only through histopathologic examination as neuroimaging is non-specific. Different studies have been conducted on the use of in vivo proton MR spectroscopy for specifying pyogenic brain abscess and differentiating between brain abscess and glioblastoma multiforme[4-9]. The cause of brain abscesses can not be specified using conventional MR imaging. Conventional MR features do not differentiate between pyogenic abscess and tuberculosis[10-12]. Recently, tuberculous features of the central nervous system were characterized using magnetization transfer (MT) MR imaging. The concentration of amino acids and proteins influences the MT ratio, which may be helpful in differentiating tuberculosis and pyogenic abscess[13].In this study, both in-vivo MR spectroscopy and MT MR imaging were used to suggest the diagnosis of subjects having multiple tuberculous brain abscesses. MT ratios and metabolite levels in pyogenic and tuberculous abscesses were also compared. Considering the abundance of lipids in abscesses caused by Mycobacterium tuberculosis and the abundance of hydrolytic enzymes, causing a high concentration of amino acids and proteins, in pyogenic abscess this study aimed to find whether in vivo proton MR spectroscopy and magnetization transfer (MT) MR imaging can be used to differentiate between tuberculous brain abscess and pyogenic brain abscess.

METHODOLOGY

The study was conducted in the Radiology Department of Ibn_e_Sina Hospital Multan from January 2021 to January 2022. The study included 15 subjects with brain abscesses who underwent in vivo MR spectroscopy, MT MR imaging and conventional MR imaging. Those with other systemic diseases were excluded. These techniques were also performed on 10 sex and age-matched control subjects for comparing MT ratios in normal and diseased parenchymal locations. 13 tuberculous abscesses were found in 4 patients, and 20 pyogenic abscesses were found in 11 patients. (Staphylococcus aureus (n=7), Streptococcus faecalis (n=5), Proteus mirabilis (n=3), Klebsiella pneumoniae (n=1), Escherichia coli (n=1), sterile (n=6)). There were 5 females and 10 males, aged from 10-50 years. All the subjects tested negative for the Human immunodeficiency virus. No pulmonary focus of infection was found in any of the subjects having tuberculous brain abscesses. MT MR imaging and in vivo MR spectroscopy were used to evaluate suspected brain abscesses. Aspiration and pus culture-confirmed pyogenic abscess. Diagnosis in 4 subjects having tuberculous brain abscesses was done through Ziehl -Neelsen staining of acid-fast bacilli in the abscess cavity wall and a pus and pus culture showing M tuberculosis. 1.5-T MR imaging system was used for spectroscopy and MR imaging. 14 patients also underwent post-contrast imaging after receiving gadopentetate dimeglumine (0.1 mmol/kg) intravenously. In a single subject with a tuberculous abscess, post-contrast imaging was not done as the subject refused to get a gadopentetate dimeglumine injection. MT ratios were calculated (through the formula (S0-Smt/S0)× 100) after the evaluation of MR images[14]. Values were obtained repeatedly for reliability and consistency. In 10 healthy control subjects, MT ratios from cortical grey matter, grey and white matter, cerebrospinal fluid and scalp fat were obtained. Spin-echo and/or stimulated echo acquisition mode (STEAM) was used for Single-voxel MR spectroscopy. In vivo, MR spectroscopy was performed for abscesses more than 2 cm in size. This criterion was matched by only 4 tuberculous abscesses. All subjects with tuberculous abscess and 7 out of 11 subjects with pyogenic abscess and aspirated pus were evaluated using ex vivo MR spectroscopy.

RESULTS

In 10 healthy control subjects mean MT ratios were as follows: from deep grey matter 24.80±0.02, cortical grey matter 27.7±0.54, scalp fat 8.3±0.5, Cerebro spinal fluid 23.67±1.1 and white matter

36.2±1.26. In MR spectroscopy major resonance of total creatine occurred at 3.01 ppm, choline-containing compounds at 3.21 ppm and N acetyl aspartate at 2.01 ppm. The mean MT ratio of the pyogenic brain abscesses was 25.55±1.60.MR spectroscopy showed that in pyogenic abscesses level of amino acids (valine, isoleucine, leucine) was 0.8 ppm and lipid and lactate was 1.2 ppm. Additionally, acetate, 1.91 ppm; glycine, 3.55 ppm; succinate,2.40 ppm and alanine, 1.47 pm were also seen. Four patients had 13 tuberculous abscesses. The mean MT ratio obtained from tuberculous abscesses was 19.87±1.54, which was significantly lower compared to the cortical grey matter, deep grey matter, white matter and pyogenic abscess (p<.001). In 4 out of 13 tuberculous abscesses, the amino acid was not visible at the level of 0.8 ppm and lactate and lipid levels were 1.2ppm.In 3 out of 5 abscesses, spin-echo imaging showed choline-containing compounds. In these 3 cases, ex vivo MR spectroscopy confirmed the findings of in vivo study.

Table 1: Result Summary

Abscess	MT ratio	Finding on In Vivo MR Spectra	Findings on Ex Vivo MR Spectr
Tuberculous n=13	19.87±1.54	Lipid, choline lactate.	Lipid, alanine lactate, glycine
Pyogenic n=20	25.55±1.60	Succinate, valine, leucine, alanine, isoleucine, glycine, acetate, lactate and lipid	Succinate, valine, leucine, alanine, isoleucine, glycine, acetate, lactate and lipid

DISCUSSION

MR imaging of brain abscesses is non-specific [10,12].In vivo MR spectroscopy of pyogenic brain abscess usually shows amino acids level of 0.8 ppm and lipid and lactate level of 1.2 ppm. In the pyogenic brain abscess, amino acids are present pathologically, necrotic cavity results in the release of a large number of protein and neutrophils. Neutrophil breakdown results in the release of proteolytic enzyme causing hydrolysis of proteins into amino acids[14]. It is the reason that in vivo MR spectroscopy of pyogenic brain abscess shows amino acids. While in tuberculous abscess a large number of mycobacteria are found along with a small number of neutrophils in necrotic tissues and pus. Lipids are predominant in mycobacteria[15]. As compared to pyogenic inflammation, tuberculous inflammatory exudate has less proteolytic enzyme[16].In tuberculous abscess, no amino acids were observed at 0.8 ppm due to the absence of proteolytic enzyme and the presence of mycobacteria in the large amount. Choline is associated with benign inflammatory conditions such as xanthogranuloma and stroke[17,18]. The presence of choline is due to cellular margins of lesions being included in voxel during MR spectroscopy[19]. In our study, three tuberculous abscesses showed choline which is probably due to cellular margins of lesions being included in voxel during MR spectroscopy. The appearance of tuberculomas on T2 weighted images is usually hypointense[20]. Intracranial tuberculoma is characterized by the spectral pattern of the hypointense lesion. On MT T1-weighted images tuberculoma wall appears hyperintense and the MT ratio ranges from 18%-22%[13].In our study, all tuberculous abscesses showed hypointense peripheral rim and hyperintense centre on T2 weighted image. Tuberculoma viewed on MT MR spectroscopy was different from these lesions. Results of MR spectroscopy and conventional MR imaging in 11 patients were consistent with previous literature and were diagnosed as a pyogenic abscess. The spectral pattern observed in tuberculous abscesses was similar to the one observed in cystic glioblastoma multiforme[8,9]. However, lesions appeared like an abscess on conventional MR imaging. It is noteworthy that the MT ratio of the granulomas tuberculoma is the same as non-specific tuberculous abscess having a large number of M tuberculosis[21]. The MT ratio in fungal and pyogenic meningitis is found to be significantly higher than in tuberculous abscesses [13]. A large number of mycobacteria are found in the wall of tuberculous abscesses, and inflammatory cells are present in the wall of the pyogenic abscess. In tuberculous brain abscess, only 30 % of individuals have the pulmonary focus of infection[21]. Due to this diagnosis of tuberculous brain abscess is difficult owing to non-specific imaging features. In our study, tuberculosis was not detected elsewhere in the body so spin-echo MR was not useful. In such cases, the diagnosis should be based on MT MR imaging and spectroscopy.

CONCLUSION

MT ratios in tuberculous brain abscesses were lower than in pyogenic abscesses. In vivo, MR spectroscopy in pyogenic abscesses did not show amino acids. Tuberculous brain abscess can be differentiated from the pyogenic abscess by using both in vivo MR spectroscopy and MT MR imaging.

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