DIAGNOSTIC ACCURACY OF SWI MRI FOR DIAGNOSIS OF GLIOBLASTOMA

ABSTRCAT

Objective: To determine Diagnostic accuracy of SWI MRI for diagnosis of glioblastoma taking biopsy as gold standard.

Material and methods: This cross-sectional study was done at department of Radiology, Jinnah Postgraduate Medical Center, Karachi from 4th June to 3rd December 2017. Total 114 patients with focal neurological deficit, symptoms of increased intracranial pressure, seizures, stroke and CT scan findings of a mass with irregular thick margins were included. All patients underwent SWI MRI. Biopsy of the brain was done during same hospitalization period. The sensitivity, specificity, PPV, NPV, DA of SWI MRI were calculated using biopsy diagnosis of glioblastoma as gold standard.

Results: There were 60.5% male and 39.5% female patients with mean age 50.64 years. Mean lesion size was 4.34 cm with standard deviation 1.46 cm. 68.4% were diagnosed with glioblastoma by SWI MRI and 71.1% patients with biopsy. Sensitivity, Specificity, PPV, NPV and accuracy were 90.1%, 84.8%, 93.5%, 77.7%, and 88.59% respectively.

Conclusion: SW Imaging with Sensitivity, Specificity, and diagnostic accuracy of 90.1%, 84.8%, and 88.59% respectively are additional help in clinical practice to confirm the assumed diagnosis.

Keywords: Awareness, Peripheral Vascular Disease, Healthcare Practitioners

Introduction

Prevalence of glioblastoma is about 43%.[1]There are several possible causes for this increase, including improved diagnostic methods, such as modern radiologic imaging, and better access to neurosurgical services. Incidental findings of brain neoplasms increased with the introduction of CT and MRI technology in the 1980s. However, it has also been suggested that the overall increase in incidence is leveling off, whereas the increasing trend continues in the older age groups.[1]

Although lymphomas demonstrate some of characteristic magnetic resonance imaging (MRI) findings, their MR imaging features can vary with immune status and histological type and often overlap with other intracranial tumors making definitive diagnosis difficult.[2] In particular, it is difficult or even impossible to distinguish between lymphoma and glioblastoma due to the similarity. Incidence of Primary central nervous system lymphoma (PCNSL) has since stabilized in the developed world with a slight decrease since the mid-1990s observed in the United States. Unlike systemic lymphoma, PCNSL typically presents with neurological symptoms. In a study of 248 patients with lymphoma, patients presented with symptoms of raised intracranial pressure, focal deficits, and seizures, ocular and neuropsychiatric symptoms.[2] Susceptibility-weighted imaging (SWI) is a new MR imaging technology developed in recent years. Differing from the conventional T1WI and T2WI, SWI is sensitive to T2 caused by local susceptibility. This new technology has been proved to be a very valuable tool in the assessment of intracranial mass lesions. SWI is able to demonstrate the differences of tissues with susceptibilities and provide excellent contrast between blood products, venous blood vessels, iron-laden and calcification distinguishable from the surrounding tissues, which is not provided by conventional MR imaging.[3] In fact, hemorrhage and infarction was rarely seen in lymphomas

probably because of outstripping of its blood supply. It has been shown that cerebral lymphomas tend to have low relative cerebral blood volume (rCBV) values and appear to be significantly lower than those of enhancing glioblastomas. Similarly, the micro vessel density, a pathological feature closely related to rCBV value, is much lower in lymphomas than in glioblastoma. Vascular proliferation is one of the most essential factors in the biological behaviors of malignant brain tumors. It is generally accepted that the more malignant the glioblastoma, the greater the degree of hemorrhage and intralesional vasculature.[4] It has also been reported that brain metastases increased the tumor micro vascularity and neovascularity leading to increased relative cerebral blood volume (rCBV) during the process of growth and invasion. In contrast with the glioblastoma and brain metastases, lymphoma is scarce in tumor neovascularization. On conventional angiography, lymphoma is usually present as an avascular mass, which is classically considered to be helpful for distinguishing itself from other malignant tumors abundant in neo vasculatures Therefore, differences in vascular proliferation between lymphoma and high-grade gliomas or brain metastases provide the basis for possible differential diagnosis made by SWI.[4] Lymphoma has been documented to possess many imaging features which may mimic glioblastoma. In a recent study of 26 lymphoma patients, only 39% of cases were accurately diagnosed on MR imaging alone.[5] Unlike most other brain tumors, radical surgical excision of PCNSLs is not warranted because the lesions are highly infiltrative.[5] Even partial tumor resection appears to be a negative prognostic factor. PCNSL is a chemo sensitive and radiosensitive tumor and an early diagnosis may shift the treatment from extensive surgery to radiotherapy. The accurate diagnosis of a PCNSL is crucial for the treatment and prognosis of the patient. The typical imaging features of PCNSLs have been described and characterized in previous studies. But previous reports have not yet systematically compared the different imaging features of monofocal and multifocal PCNSLs. This comparison would be helpful for the differential diagnosis and prediction of clinical prognosis to compare monofocal and multifocal PCNSLs.[5] In addition, owing to their diffuse infiltrative or invasive growth lymphoma and glioblastoma display similar MR patterns. Therefore, it is often difficult, to differentiate these tumors by the conventional MR imaging. Use of SWI in this setting is very helpful. In one study it was found that in about 82.2% of cases glioblastoma was diagnosed with SWI modality.[6] One recent study has shown 83.6%% sensitivity and 81.5% specificity of SWI MRI for diagnosis of glioblastoma.[7] An accurate diagnosis is crucial since prognosis and therapy are completely different for glioblastoma from lymphoma which share common MR features with glioblastoma. MRI without SWI has very low rate of diagnostic accuracy while histopathology is an invasive test. This calls for a study that is noninvasive, available and sensitive to document glioblastoma. The rationale of my study is to find out whether SWI MRI which is a non-invasive and easily available technique has any role for the early detection of intracranial glioblastoma and to differentiate it with other similar looking intracranial tumors. No recent study has been done in Karachi regarding this study, so my study will help to find out diagnostic accuracy of SWI MRI in detection of intracranial glioblastoma in our population.

MATERIAL AND METHODS

This cross-sectional study was conducted Department of Radiology, Jinnah Postgraduate Medical Center, Karachi. During six months from 4th June to 3rd

December 2017. All the new admitted patients presented with focal neurological deficit, symptoms of increased intracranial pressure, seizures, stroke like symptoms due to intra tumoral hemorrhage, with CT scan findings of a mass with irregular thick margins: iso to slightly hyperattenuating (high cellularity), irregular hypodense Centre representing necrosis, marked mass effect, surrounding vasogenic oedema, haemorrhage, intense irregular, heterogeneous enhancement of the margins and patient of age >30 and <70 years of either gender were included. All the patients with previous radiotherapy, previous chemotherapy, previous surgery and not consenting to participate in the study were excluded. Baseline demographic data i.e. age and sex were recorded in proforma. All the patients underwent SWI MRI. After the procedure patients were shifted to ward and provided standard medical treatment. Biopsy of the brain was done during same hospitalization period. The samples of biopsy were preserved in Normal Saline and Formalin and were sent to histopathology laboratory of Pathology department of Jinnah Postgraduate Medical Center. The reports were verified by consultant histopathologist at the lab. The MRI examinations were obtained on a whole-body Philips 1.5 MR scanner, with actively shielded imaging gradients, in conjunction with an eight-channel head coil. All sequences were aligned parallel to the midline structures and covered from the base of the skull to the vertex. The susceptibility-weighted sequence was a flow-compensated 3D gradient echo sequence, and the imaging parameters were as follows: TE = 20 ms; TR = 28 ms; field of view = 230 × 230 mm; number of slices = 80; slice thickness = 1.75 mm; slice gap = 0 mm; flip angle = 15. All MR images were reviewed by two radiologists having more than 5-year experience blinded of surgical or pathological results. The imaging features analysis were included tumor location, and size of tumor. Intralesional hemorrhagic burden and Intralesional vessel score were also counted and graded as per operational definitions on SWI. Data were analyzed in SPSS version 26.

RESULTS

There was 60.5% male and 39.5% female patients with mean age 50.64 years ranging from 31 years to 64 years. The overall mean lesion size was 4.34 cm with standard deviation 1.46 cm. Out of 114 patients, 41.2% have lesion at frontal region, 31.6% at parietal region and 27.2% at occipital region. Out of all 68.4% cases were diagnosed with glioblastoma by SWI MRI. As far as biopsy findings are concerned, glioblastoma was diagnosed in 71.1% patients. Table-1.

Sensitivity, Specificity, Predictive values and diagnostic accuracy of SWI MRI for the detection of glioblastoma taking biopsy as gold standard were calculated. The results showed that 73 patients were true positive, correctly diagnosed and 28 patients were true negative, correctly diagnosed. Sensitivity, Specificity, PPV, NPV and accuracy were 90.1%, 84.8%, 93.5%, 77.7%, and 88.59% respectively as presented in Table-2.

Table - 1 Descriptive statistics of demographic characteristics and diagnosis of Glioblastoma n=114

Variables		Statistics
Age		50.64±10.37 years
Gender	**Males**	69(60.5%)
	Females	45(39.5%)
Lesion size	**<3cm**	9(8.0%)
	≥3cm	105(92.0%)
Lesion location	**Frontal Region**	47(41.2%)
	Parietal region	36(31.6%)
	Occipital region	31(27.2%)
Diagnosis of Glioblastoma by SWI MRI	**Yes**	78(68.4%)
	No	36(31.6%)
Diagnosis of Glioblastoma by Biopsy	**Yes**	81(71.1%)
	No	33(28.9%)

TABLE – 2. Diagnostic accuracy of SWI MRI with biopsy as gold standard for diagnoses of Glioblastoma n=114

SWI MRI	**BIOPSY**			**P-VALUE**
	Yes	**No**	**TOTAL**	
Yes	73 (90.1%)	5(15.2%)	**78(68.4%)**	**0.000***
No	8(9.9%)	28(84.8%)	**36(31.6%)**	
TOTAL	**81**	**33**	**114**	
Sensitivity	**Specificity**	**PPV**	**NPV**	**Accuracy**
90.1%	**84.8%**	**93.58%**	**77.7%**	**88.59%**

Chi square test was applied. P-Value ≤0.05 considered as significant. *Significant at 0.05levels.

DISCUSSION

The differential diagnosis of brain tumors is a major question in clinical MRI reading. The clinical symptoms depend on the tumor location and therefore are not helpful for the differential diagnosis. It is possible that patients with these tumors have no symptoms, just headache or focal neurological deficits up to seizures. In most cases the medical history is short, i. e., only weeks to a month, because both tumors grow fast.[8]

With regular MR images, it is often not possible to distinguish between these tumors. Both appear to be hyper intense in T2-weighted images and hypo intense in T1-weighted images. However, this criterion is not reliable and it can be difficult to distinguish glioblastomas from primary cerebral lymphomas in certain cases. There are reports stating that both tumors show a different appearance in susceptibility-weighted images (SWI) .[9]

In this study there was 60.5% male and 39.5% female patients with mean age 50.64 years ranging from 31 years to 64 years. On other in the study of Min TL et al[10] reported that the males were in majority compared to females and average age of the patients was 61.7 ± 2.2 years. In another study of Law M et al[11] demonstrated that the patients' ages ranged from 4 to 82 years old, with a mean of 43 years old and 108 males and 52 females among them. In this study out of 114 patients, 41.2% have lesion at frontal region, 31.6% at parietal region and 27.2% at occipital region. Out of all 68.4% cases were diagnosed with glioblastoma by SWI MRI, while as per biopsy findings are concerned, glioblastoma was diagnosed in 71.1% patients and sensitivity, Specificity, Predictive values and diagnostic accuracy of SWI MRI for the detection of glioblastoma taking biopsy as gold standard were calculated. The results showed that 73 patients were true positive, correctly diagnosed and 28 patients were true negative, correctly diagnosed. Sensitivity, Specificity, PPV, NPV and accuracy were 90.1%, 84.8%, 93.5%, 77.7%, and 88.59% respectively. Law M et al[11] demonstrated that the sensitivity, specificity, PPV, and NPV for determination of a high-grade glioma with conventional MR imaging were 72.5%, 65.0%, 86.1%, and 44.1%, respectively. Peters S et al[6] demonstrated that the by additionally using susceptibility-weighted images, the radiologists determined the correct diagnosis in 82.2 % of the cases. Without susceptibility-weighted images, the diagnosis was correct in 75.5 % of the cases and the sensitivity for diagnosing a glioblastoma was 90.5 % and the specificity was 100 % if there was a high rate of intra tumoral susceptibility signals (grade 3). Kong LW et al[12] reported that they used a standard SWI grading method to identify correlations between ITSS imaging features and tumor as well as molecular pathology, and confirmed the findings of previous studies that showed that SWI plays an important role in predicting the status of molecular glioma markers and they discovered that these SWI imaging properties are linked to tumor molecular marker status. This research offers fresh ideas for non-invasive glioma molecular genetics prediction, as well as a solid foundation for preoperative surgical treatment based on molecular pathology. Xu J et al[13] also observed that the SWI may have a complementary diagnostic role for grading of gliomas. SWI is a relatively novel MRI technique with a 3D high-resolution gradient-echo sequence (GRE) sensitive to structures producing susceptibilities such as blood, iron, and calcification in the tissues.[14] Susceptibility-weighted imaging (SWI) is a technique that uses the difference in susceptibility between tissues to produce contrast for distinct brain regions.[15] In essence, it leverages intrinsic contrast agents such as deoxygenated haemoglobin from veins, hemosiderin from haemorrhage, and others to allow for much greater visibility of blood and micro vessels without the use of an external contrast agent. It's a rapidly changing field that's always being enhanced and increasingly implemented as new technology becomes available.[15] This was as a single-center experience, low female representation and nonrandomized study design study and it was conducted with small sample size therefore, the results might not be generalizable to larger populations.

Conclusion

The results showed that SW Imaging with Sensitivity, Specificity, PPV, NPV and diagnostic accuracy of 90.1%, 84.8%, 93.5%, 77.7%, and 88.59% respectively are additional help in clinical practice to obtain the correct diagnosis or to confirm the assumed diagnosis. Patients with suspected glioblastomas are primarily operated; a primary biopsy is usually performed in patients with a suspected lymphoma. Further, diagnosis accuracy increases by additionally using SW imaging in an MR-tumor protocol.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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