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Original Research Article

DIAGNOSTIC ACCURACY OF MAGNETIC RESONANCE IMAGING IN DETECTING POSTERIOR LAMINAR OPTIC NERVE INVASION IN RETINOBLASTOMA PATIENTS, TAKING HISTOPATHOLOGY FINDINGS AS GOLD STANDARD

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ABSTRACT

Background: The objective is to determine diagnostic accuracy of magnetic resonance imaging in detecting posterior laminar optic nerve invasion in retinoblastoma patients, taking histopathology findings as gold standard. Design is descriptive, cross-sectional. Place & duration of study Department of Radiology, Jinnah Hospital, Lahore from June 2025 to December 2025.

Materials and Methods: A total of 168 patients with suspected retinoblastoma, 6 months-10 years of age of both genders were included. Patients with h/o thyrotoxicosis, trauma to eye and contraindication to magnetic resonance imaging i.e. MRI incompatible prosthesis or cardiac pacemaker holders were excluded. After this, magnetic resonance imaging (MRI) was performed in every patient and looked for posterior laminar optic nerve invasion in retinoblastoma patients. MRI findings were compared with histopathology report.

Results: In MRI positive patients, 87 (True Positive) had posterior laminar optic nerve invasion and 08 (False Positive) had no posterior laminar optic nerve invasion on histopathology. Among 73, MRI negative patients, 07 (False Negative) had posterior laminar optic nerve invasion on histopathology whereas 66 (True Negative) had no posterior laminar optic nerve invasion on histopathology (p=0.0001). Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of magnetic resonance imaging in detecting posterior laminar optic nerve invasion in retinoblastoma patients, taking histopathology findings as gold standard was 92.55%, 89.19%, 91.58%, 90.41% and 91.07% respectively.

Conclusion: This study concluded that MRI is a highly sensitive and accurate non-invasive modality for diagnosing retinoblastoma.

Keywords: Retinoblastoma, Magnetic Resonance Imaging, Sensitivity.

INTRODUCTION

Retinoblastoma (RB), the most common primary intraocular tumor in children, occurs unilaterally in 60% of patients. In the vast majority of patients, unilateral RB is nonhereditary, and only 10% to 15% of patients carry a germ line mutation.[1] In developed countries, patients with unilateral RB typically present at around.[2] years of age with disease that is still confined to the ocular globe but has reached an advanced stage, so that conservative treatment with chemotherapy and local adjuvant therapy is often no longer an option.[2] In most cases, after ruling out regional extension on clinical and radiologic findings, enucleation is performed.[3]

Retinoblastoma typically develops in children under the age of.[5] and is accountable for 4% of all cancers in children below the age of.[15] Retinoblastoma affects about one in 20,000 children and is diagnosed in 250 to 350 children every year in the United States and 5000 worldwide. Developing countries in east Africa have reported survival rates as low as 30% due to the lack of treatment and overall health (Chantada). The USA reported a 90% survival rate for early detection in children due to the availability of treatment options. Retinoblastoma affects everyone equally. Retinoblastoma is not bias to gender, race, or environments. The estimated male to female ratio is.[1.12] to.[1] There have been very few cases of RB that have been reported over the ages of.[20] and is thought to be caused by malignant transformation. Ninety percent of all children who have retinoblastoma are diagnosed with the sporadic mutation making them the first ones in their family to have the cancer. The other ten percent is caused by inheritance and usually exhibit the bilateral form of the cancer. If a parent had or has the bilateral (both eyes) form of retinoblastoma and produced offspring there is a 45% of passing it on. If a parent had or has the unilateral (one eye) form of retinoblastoma, 7% to 15% of their children could have the mutation.[4]
Fundoscopy and ultrasonography (US) can be used to accurately stage intraocular retinoblastoma and distinguish it from other ocular lesions. To detect risk factors beyond what can be detected with fundoscopy and US, histopathologic analysis is required.[4] Magnetic resonance (MR) imaging can be used to assess these risk factors, though not as reliably as histopathologic examination.[5] Massive choroidal invasion (invasion of at least 3 mm in terms of thickness or width of the tumor into the choroid or touching the sclera), scleral invasion, and postlaminar optic nerve invasion (PLONI) are considered metastatic risk factors (especially concomitant PLONI and massive choroidal or scleral invasion).[6] In a study, posterior laminar optic nerve invasion in retinoblastoma patients was found to be in 55.5% patients.[7] MRI has shown the sensitivity of 60.0% and specificity of 95.0% in detecting posterior laminar optic nerve invasion in retinoblastoma patients.[8]
As the available literature on the sensitivity and specificity of MRI in detecting posterior laminar optic nerve invasion in retinoblastoma patients is very scarce and we have found no local study in this aspect, so I had planned to conduct this study to determine the diagnostic accuracy of magnetic resonance imaging in detecting posterior laminar optic nerve invasion in retinoblastoma patients taking histopathology findings as gold standard. My study will not only provide the local stats but will also be a useful addition in the existing literature. Moreover, if it's diagnostic accuracy will be found high, then this non-invasive imaging modality can be used routinely in our general practice for detecting posterior laminar optic nerve invasion in retinoblastoma patients accurately and to select a better treatment plan pre-operatively for these particular patients in order to reduce their morbidity.

MATERIALS AND METHODS

This descriptive, Cross-sectional study was conducted in department of Radiology, Jinnah Hospital, Lahore from June 2025 to December 2025. After approval from the ethical review committee, a total of 168 patients with suspected retinoblastoma, 6 months-10 years of age of both genders were included. Patients with h/o thyrotoxicosis, trauma to eye and contraindication to magnetic resonance imaging i.e. MRI incompatible prosthesis or cardiac pacemaker holders were excluded. After this, magnetic resonance imaging (MRI) was performed in every patient and looked for posterior laminar optic nerve invasion in retinoblastoma patients. All magnetic resonance imaging findings were interpreted by a consultant radiologist (with at least 5 years' post-fellowship experience) in the presence of researcher. MRI findings were compared with histopathology report.
Collected data was analyzed through computer software SPSS 20.0. Mean and standard deviation were calculated for age and duration of disease. Frequency and percentage were calculated for gender, side affected (right/left), posterior laminar optic nerve invasion in retinoblastoma patients on MRI and histopathology (present/absent). 2×2 contingency table was used to calculate the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of MRI in detecting posterior laminar optic nerve invasion in retinoblastoma patients, taking histopathology as gold standard.
Effect modifiers like age, gender and duration of disease were controlled through stratifications and post-stratification chi square was applied to see their effect on outcome. P-value ≤ 0.05 was considered as significant.

RESULTS

Age range in this study was from 6 months-10 years with mean age of 4.74 ± 2.23 years. Majority of the patients 123 (73.21%) were between 6 months-5 years of age as shown in Table I.
Out of these 168 patients, 95 (56.55%) were males and 73 (43.45%) were females with ratio of 1.3:1. Mean duration of disease was 4.42 ± 1.55 months (Table-II). Right eye was affected in 89 (52.98%) while left eye was involved in 79 (47.02%).
All the patients were subjected to orbital MRI and MRI supported the diagnosis of posterior laminar optic nerve invasion in 95 (56.55%) patients and no posterior laminar optic nerve invasion in 73 (43.45%) patients. Histopathology findings confirmed posterior laminar optic nerve invasion in 94 (55.95%) patients and no posterior laminar optic nerve invasion in 74 (44.05%) patients. In MRI positive patients, 87

(True Positive) had posterior laminar optic nerve invasion and 08 (False Positive) had no posterior laminar optic nerve invasion on histopathology. Among 73, MRI negative patients, 07 (False Negative) had posterior laminar optic nerve invasion on histopathology whereas 66 (True Negative) had no posterior laminar optic nerve invasion on histopathology (p=0.0001) as shown in Table III.

Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of magnetic resonance imaging in detecting posterior laminar optic nerve invasion in retinoblastoma patients, taking histopathology findings as gold standard was 92.55%, 89.19%, 91.58%, 90.41% and 91.07% respectively.

Table 1: Distribution of patients according to Age

Age (years)	No. of Patients	%age
6 months-5 years	123	73.21
6-10 years	45	26.79
Total	168	100.0

Table 2: Distribution of patients according to duration of disease.

Duration of disease	No. of Patients	%age
≤3 months	54	32.14
>3 months	114	67.86
Total	168	100.0

Mean ± SD = 4.42 ± 1.55 months

Table 3: Diagnostic accuracy of magnetic resonance imaging in detecting posterior laminar optic nerve invasion in retinoblastoma patients, taking histopathology findings as gold standard.

	Positive result on Histopathology	Negative result on Histopathology	P-value
Positive result on MRI	87 (TP)*	08 (FP)***	0.0001
Negative result on MRI	07 (FN)**	66 (TN)****	

*-TP=True positive **-FP=False positive ***-FN=False negative ****-TN=True negative
Sensitivity: 92.55%
Specificity: 89.19%
Positive Predictive Value (PPV): 91.58%
Negative Predictive Value (NPV): 90.41%
Diagnostic Accuracy: 91.07%

DISCUSSION

MRI is used to assess intraocular spread including invasion of the optic nerve, extraocular as well as intracranial extension. Inherited forms of retinoblastoma may be associated with primary tumors of the suprasellar or pineal region. Involvement of optic nerve or choroid infiltration is an important predictor of metastases in retinoblastoma. Involvement of optic nerve beyond lamina cribrosa is associated with poor prognosis. MRI shows disruption of linear enhancement at choroidoretinal complex or thickening of enhancing choroidoretinal complex in prelaminar optic nerve involvement. Postlaminar optic nerve involvement is seen as focal optic nerve enhancement and/or thickening.[9] I have conducted this study to determine diagnostic accuracy of magnetic resonance imaging in detecting posterior laminar optic nerve invasion in retinoblastoma patients, taking histopathology findings as gold standard.

Age range in this study was from 6 months-10 years with mean age of 4.74 ± 2.23 years. Majority of the patients 123 (73.21%) were between 6 months-5 years of age. Out of these 168 patients, 95 (56.55%) were males and 73 (43.45%) were females with ratio of 1.3:1. In MRI positive patients, 87 (True Positive) had posterior laminar optic nerve invasion and 08 (False Positive) had no posterior laminar optic nerve invasion on histopathology. Among 73, MRI negative patients, 07 (False Negative) had posterior laminar optic nerve invasion on histopathology whereas 66 (True Negative) had no posterior laminar optic nerve invasion on histopathology (p=0.0001). Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of magnetic resonance imaging in detecting posterior laminar optic nerve invasion in retinoblastoma patients, taking histopathology findings as gold standard was 92.55%, 89.19%, 91.58%, 90.41% and 91.07% respectively. In a study, posterior laminar optic nerve invasion in retinoblastoma patients was found to be in 55.5% patients.[7] MRI has shown the sensitivity of 60.0% and specificity of 95.0% in detecting posterior laminar optic nerve invasion in retinoblastoma patients.[8]

Chawla et al10 analyzed 75 group E eyes and found that the MRI had an 84% accuracy (sensitivity, 60%; specificity, 90%) in predicting prelaminar optic nerve invasion, and 76% accuracy (sensitivity, 62%; specificity, 82%) in predicting postlaminar optic nerve invasion. On the other hand, Chawla et al,[9] reported detecting laminar invasion with an 82% accuracy, and this may be due to the difference in the level of suspicion and experience of neuroradiologists. This is better described by Wilson et al,[10] who showed an modest agreement of 63% between two different neuroradiologists in evaluating the optic nerve invasion in MRI.

A systematic review and meta-analysis.[11] including .[14] studies on MRI, the summary estimates with their

95% confidence intervals (CIs) of the diagnostic accuracy of conventional MRI at detecting postlaminar optic nerve, choroidal, and scleral invasion showed sensitivities of 59% (95% CI, 37%-78%), 74% (95% CI, 52%-88%), and 88% (95% CI, 20%-100%), respectively, and specificities of 94% (95% CI, 84%-98%), 72% (95% CI, 31%-94%), and 99% (95% CI, 86%-100%), respectively. Magnetic resonance imaging with a high (versus a low) image quality showed higher diagnostic accuracies for detection of prelaminar optic nerve and choroidal invasion, but these differences were not statistically significant.[12]

Optic nerve invasion is one of the primary histopathological risk factors due to its association with a high mortality rate. Surgical treatment is always preferred if there is evidence of optic nerve invasion.[12,13] Abnormal optic nerve (prelaminar or postlaminar) enhancement is generally regarded as a high risk of optic nerve invasion, especially postlaminar enhancement.[13,16] The sensitivity and specificity of MRI for depicting postlaminar optic nerve invasion were reported to be approximately 50%−69% and 65%−90%, respectively.[14-17] However, false positive findings of optic nerve enhancement without postlaminar optic nerve invasion have been reported for tumors, causing bulging of the lamina before invading the optic nerve beyond the lamina cribrosa.[14,17] or secondary to inflammation of the optic disc.[13] leading to the use of more conservative treatment approaches.[18]

The study had some limitations. It was conducted at a single center, which may limit generalizability. MRI findings were interpreted by a single radiologist, so inter-observer variability could not be assessed. In addition, the study focused only on posterior laminar optic nerve invasion and did not evaluate other high-risk pathological features. Larger multicenter studies using standardized MRI protocols are recommended.

CONCLUSION

This study concluded that magnetic resonance imaging is a highly sensitive and accurate non-invasive modality for detecting posterior laminar optic nerve invasion in retinoblastoma patients, and has not only dramatically improved our ability of accurate diagnosis of retinoblastoma but also improved patient care by timely and proper treatment. So, we recommend that magnetic resonance imaging should be used routinely as a prime modality for assessment of retinoblastoma which will result in proper and timely management for reducing the morbidity and mortality of these particular patients.

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