Original Article
DOI: https://doi.org/10.70749/ijbr.v3i5.1344

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

Crossref

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# Diagnostic Accuracy of Post Contrast Magnetic Resonance Imaging for Meningitis Taking Lumbar Puncture as Gold Standard

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## ARTICLE INFO

**Keywords:** Diagnostic Accuracy, Post Contrast Magnetic Resonance Imaging, Meningitis.

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**Declaration**
**Authors' Contribution:** Both authors equally contributed to the study and approved the final manuscript.
**Conflict of Interest:** No conflict of interest.
**Funding:** No funding received by the authors.

**Article History**
Received: 03-01-2025, Revised: 02-04-2025
Accepted: 19-04-2025, Published: 17-05-2025

## ABSTRACT

**Background:** Meningitis is a life-threatening condition that requires early diagnosis and immediate medical attention. MRI detects meningeal enhancement with greater sensitivity and specificity. **Objective:** The aim of this study was to find out the Diagnostic accuracy of post contrast magnetic resonance imaging for meningitis taking Lumbar puncture as gold standard. **Material and Method:** The current descriptive Cross-sectional study was carried out at the department radiology in Lady reading hospital Peshawar over a period of 6 months from March 2023 to Aug 2023 after taking approval from the research unit of college of physicians and surgeon of Pakistan and ethical board of the institute. The sample size was find out using WHO calculator .a total of 202 individuals of both gender and different age groups (2-70 years) with suspected meningitis based on clinical presentations were included. Demographic features like gender, age, address of the participants were recorded .physical description and medical history of the patients were also noted. All the participants underwent MRI scan of the brain (vertex to the base of the skull) by using Tesla 1.5 MR unit Syngo.The results were noted. Then the CSF were collected through Lumbar Puncture from each individual. The results of both the MRI and Lumbar Puncture were compared. Data was analyzed through SPSS version 23. Diagnostic accuracy was measured to find the relationship between MRI patterns and cerebrospinal fluid. The sensitivity, specificity and diagnostic accuracy was determined. **Results:** A total of 202 individuals were enrolled in this study out of which 108(53.4%) were male and 94(46.5%) were females. The mean age of the study population was 25.4±23.5 years. Age wise distribution showed that the most prevalent was younger (17 years or below) (49.5%) followed by age group 18 t0 50 years, 52(25.7%). Clinical presentations among the individuals were Poor feeding, lethargy and irritability 90(45.5%), Headache 85(42.0%), and Nausea /vomiting 20(9.9%). Post contrast MRI results were positive in 96 (47.5%), negative in 106 (52.6%), while lumbar puncture results were positive in 102 (50.4%) and negative in 100 (49.5%). The post-contrast MRI showed 79% sensitivity, 84% specificity, and 80% diagnostic accuracy. **Conclusion:** Our study concluded that Post-contrast magnetic resonance imaging is the most reliable and effective diagnostic method for detecting meningitis in suspected cases, taking Lumbar puncture as gold standard.

## INTRODUCTION

The inflammation of meninges is termed as meningitis. The disease affects not only the meninges, but also the brain (encephalitis), ventricles (ventriculitis), and spinal cord (myelitis). It mostly affects children under the age of 5 and elderly people over 60.[1] Bacteria, such as tuberculosis (70%), viruses (24%), and fungal infections (6%) are all possible causes. Bacterial meningitis is the common cause of death in children .In Pakistan its prevalence is 1.57%.[2] In developed countries, the leading causes of acute bacterial meningitis (ABM) are *Neisseria meningitidis* and *Streptococcus pneumoniae*. Bacterial meningitis can lead to high mortality rates and neurological complications. If left untreated, death occurs in 100% of cases. Delay in treatment during the first few hours after presentation increases the chance of mortality by 8.4 times. The incidence is 5-7 per 100,000 people, with a death rate of 5- 10%. 20% of survivors globally suffer from a lifelong neurological impairment.[3] Acute bacterial meningitis is a life-threatening condition that requires early diagnosis and immediate medical attention. Clinical symptoms vary based on patient age and disease duration. The diagnosis is based on a history and physical examination, confirmed with lumbar puncture.[4] The most frequent neurological Sequelae are disability, hearing loss, cognitive impairment, and epilepsy.[5] Magnetic resonance imaging (MRI) is

commonly used to detect complications of meningitis, but it is now increasingly suggested for diagnostic purposes.[6] Both CT scans and MRI can identify intracranial infections, but MRI is more effective due to its ability to show soft tissue features, absence of bone artefacts, and multiplanar capacity. Gadolinium-enhanced MRI detects meningeal enhancement with greater sensitivity and specificity than contrast-enhanced CT scans.[2] Post-contrast MRI sequences are commonly utilized to identify many intracranial diseases, including CNS infections.[7] Post-contrast MRI have higher sensitivity and specificity (95.3% and 83.3%, respectively).[8] Although meningitis is prevalent in Pakistan, there is a lack of local literature on the significance of post-contrast magnetic resonance imaging for early identification. Therefore the present study was conducted to find out the diagnostic accuracy of post contrast magnetic resonance imaging for meningitis taking Lumbar puncture as gold standard.[9]

## MATERIAL AND METHOD

The current descriptive Cross-sectional study was carried out at the department radiology in Lady reading hospital Peshawar from March 2023 to August 2023 over a period of 6 months after taking approval from the research unit of college of physicians and surgeon of Pakistan and ethical board of the institute. The sample size was find out using WHO calculator .a total of 202 individuals of both gender and different age groups (2-70 years) with suspected meningitis based on clinical presentations were included while individuals on prophylactic antibiotics and had cardiac and renal disease were excluded.

### Data Collection

Only those volunteer who meet the inclusion criteria were enrolled and verbal description of the advantages, risk and aim of the study were presented to the participants .written consent were taken from all the individuals of the study. Demographic features like gender, age, address of the participants were recorded. physical description and medical history of the patients were also noted. All the participants underwent MRI scan of the brain (vertex to the base of the skull) by using Tesla 1.5 MR unit Syngo.The results were noted. Then the CSF were collected through Lumbar Puncture from each individual. The results of both the MRI and Lumbar Puncture were compared by experience consultant with a 3 years of post- fellow ship experience. All the data was recorded on a pre -designed proforma.

### Data Analysis

All the data was analyzed through SPSS version 23. Quantitative variable like age was presented as mean & standard deviation. Qualitative factors include gender, positive CSF results, and positive MRI. Diagnostic accuracy was measured to find the relationship between MRI patterns and cerebrospinal fluid. The inferential results were presented with a 95% confidence interval and a 5% significance level. A 2x2 contingency table was used to compute the sensitivity and specificity.

## RESULTS

A total of 202 individuals were enrolled in this study out of which 108(53.4%) were males and 94(46.5%) were females. The mean age of the study population was 25.4±23.5 years ranging from 2 to 70 years. Age wise distribution showed that the most prevalent was younger (17 years or below ) (49.5%) followed by age group 18 t0 50 years , 52(25.7%)as presented in **table 1.** Clinical presentations among the individuals were Poor feeding, lethargy and irritability 90(45.5%), Headache 85(42.0%), and Nausea /vomiting 20(9.9%) as presented in **table 2.** Post contrast MRI results were positive in 96 (47.5%), negative in 106 (52.6%), while lumbar puncture results were positive in 102 (50.4%) and negative in 100 (49.5%) as presented in **table 3.** The post-contrast MRI showed 79% sensitivity, 84% specificity, and 80% diagnostic accuracy as presented in **table 4.**

**Table 1**

*Distribution of the study participants by age and gender*

| Variables | Frequency /percentage |
|---|---|
| **Sex** | |
| Male | 108(53.4%) |
| Female | 94(46.5%) |
| Total | 202(100%) |
| **Age in years** | |
| 17 or below | 100(49.5%) |
| 18 to 50 | 52(25.7%) |
| 51-70 | 50(24.7%) |
| Total | 202 |
| Mean ,SD | 25.4±23.5 |

**Table 2**

*Clinical manifestations of the study participants*

| Clinical presentation | Frequency /percentage |
|---|---|
| Unconsciousness | 10(4.9%) |
| Seizures and neurological defect | 12(5.9%) |
| Neck stiffness | 5(2.4%) |
| Nausea /vomiting | 20(9.9%) |
| Headache | 85(42.0%) |
| Poor feeding , lethargy and irritability | 90(45.5%) |
| Total is not 100 % due to multiple responses | |

**Figure 1**

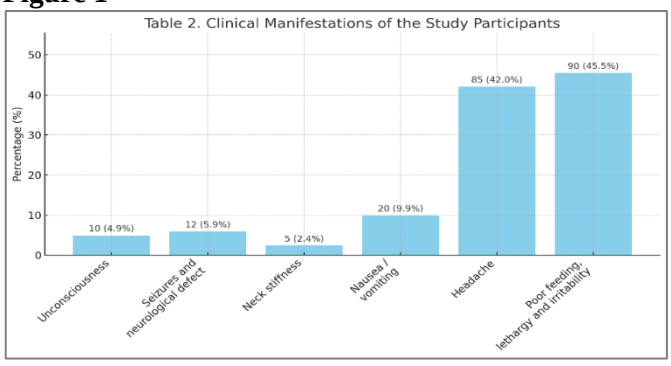

**Table 3**

*A comparison of post-contrast MRI and lumbar puncture results.*

| | Lumbar Puncture findings | |
|---|---|---|
| Post-contrast MRI results | Positive n=102 | Negative =100 |
| Positive (n=96) | True positive 80 | False positive 16 |
| Negative (106) | False negative 22 | True negative 84 |
| Total | 202 | |

**Table 4**

*Diagnostic accuracy of post contrast MRI findings with lumbar puncture as gold standard*

**Sensitive: True positive**

$$\frac{\text{True positive}}{\text{True positive + false negative}} \times 100$$

**80/ 80+22× 100 = 78.44%**

**Specificity : True negative**

$$\frac{\text{True negative}}{\text{True negative + False positive}} \times 100$$

**84/84+16**× 100 =84%

**Diagnostic Accuracy: True positive + True negative**

$$\frac{\text{True positive + True negative + False positive + False negative}}{} \times 100$$

**80+84/80+84+16+22**×100=80%

## DISCUSSION

Meningitis can cause nonspecific symptoms such as fever, poor feeding, lethargy, vomiting, and irritability. They may get a rash. Symptoms such as inconsolable weeping frustration, or growing lethargy may suggest a central nervous system (CNS) importance, such as meningitis. Meningitis symptoms, including headaches, nuchal pain, altered respiratory and neurological tests are conducted to identify neurological symptoms, postural problems, cranial nerve involvement, and alertness level. Consciousness, and other nonspecific symptoms, is more prevalent in adults than in infants. Individuals should be thoroughly investigated to diagnose meningitis, CSF analysis (cell count, glucose, and protein levels), and microbiological culture, molecular detection of bacterial DNA (if clinical suspicion is high and bacterial cultures are negative), viral studies, and tuberculosis testing (in high-risk children) are essential. A lumbar puncture (LP) should always be undertaken unless there are contraindications. Even after administering antimicrobials, molecular studies may still be effective. Consult a pathologist for more choices. Spinal taps should not be performed if there is coagulopathy, cutaneous lesions at the puncture site, or brain herniation or shock. If there is papilledema, focal neurological signs, decreased level of consciousness, or coma, an LP should be postponed until imaging (contrast-enhanced computed tomography or magnetic resonance imaging of the head) is carried out to rule out the risk of herniation. Meningitis without localized CNS lesions is unlikely to cause complications such as herniation from a Lumbar puncture. [9] In the present study a total of 202 individuals were enrolled in this study out of which 108(53.4%) were male and 94(46.5%) were females. A similar study was conducted by Bari et al. [10]in which male were in greater percentage (63.8%) which is similar to our findings. In Karachi, Fayyaz et al.[11] found 69.8% male gender preponderance, which is consistent with our findings. In Rawalpindi, Khan et al. [18] found that 58% of meningitis cases were male, which aligns with our findings. The mean age of the study population was 25.4±23.5 years ranging from 2 to 70 years. Age wise distribution showed that the most prevalent was younger, 17 years or below (49.5%). Bari et al[10] from Lahore found 11.3 ± 12 months, which is lower than our research results. This discrepancy might be attributed to our inclusion criteria. MRI has made significant contributions to detecting and characterizing brain lesions. MRI has a detection rate of over 90% for CNS lesions, compared to 77% for CT scans. It eliminates the need for invasive injections of iodinated contrast chemicals and the risk of radiation from x-rays. These MRI safety precautions benefit pediatrics and elderly individuals.[13] This study evaluated the diagnostic accuracy of MRI in meningitis patients, using cerebrospinal fluid (lumbar puncture) results as the gold standard. In our study post contrast MRI results were positive in 47.5%, negative in 52.6%, while lumbar puncture results were positive in 50.4% and negative in 49.5%. Post-contrast MRI showed 79% sensitivity, 84% specificity, and 80% diagnostic accuracy. Aneel Kumar et al[14] found that Post-Contrast MRI has a 96% sensitivity and 85.71% specificity for diagnosing meningitis, which is consistent with our findings. simialy study on meningitis was carried out by Qureshi, et a they reported that post-contrast MRI were 48% positive and 52% negative, whereas lumbar puncture yielded 51% positive and 49% negative results. The post-contrast MRI demonstrated 78.43% sensitivity, 83.67% specificity, and 81.00% diagnostic accuracy which are similar to our study findings. Our study supports all the aforementioned studies.

## CONCLUSION

Our study concluded that Post-contrast magnetic resonance imaging is the most reliable and effective diagnostic method for detecting meningitis in suspected cases, with Lumbar puncture serving as the gold standard. Its diagnostic accuracy was found 80% in the current study.

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