TRYAKSH INTERNATIONAL JOURNAL OF MEDICAL AND CLINICAL CASE STUDIES (TIJMCCS)
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Diagnostic Accuracy of Post Contrast Magnetic Resonance Imaging for Meningitis Taking Lumbar Puncture as Gold Standard. Experience at Nishtar Hospital-Multan

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Abstract

Background: One of the most serious and contagious disease, associated with considerable effects on quality of life and death rates is bacterial meningitis. Urgent diagnosis, treatment, and prevention are required in 10 to 20% of survivors with advancing debilitating neurologic complications. In developing countries, the prevalence of meningitis is usually high in low-socioeconomic status.

Objective: To determine the Diagnostic Accuracy of Post Contrast Fluid attenuation recovery sequence of Magnetic Resonance (FLAIR MR) imaging for suspected meningitis in pediatric patients taking Lumbar Puncture as Gold Standard.

Methods: The Study was done at Department of Radiology, in which calculated sample size was 100 children with suspected meningitis aged 2 – 12 years of age. MRI brain was performed from vertex to the base of skull on Philips TM Achieva 1.5 tesla (T) MR System. Following Magnetic Resonance Imaging (MRI) exam, Cerebrospinal fluid (CSF) was collected via Lumbar Puncture (LP) of each patient. The statistical analysis was done using SPSS package version 19.0.

Results: Post contrast FLAIR MRI findings were positive in 48 (48 %) while negative in 52 (52 %) while lumbar puncture revealed positive findings in 51 (51 %) while negative in 49 (49 %). Sensitivity of the post contrast FLAIR MRI was 78.43 % while specificity was 83.67 %, diagnostic accuracy was 81.00 %.

Conclusion: The most authentic, secure and potent diagnostic tool for the detection of meningitis among suspected children is post contrast FLAIR magnetic resonance imaging. Our study represents that post-contrast FLAIR MRI has high sensitivity, specificity and detecting accuracy in diagnosis of meningitis among influenced population.

Keywords: Meningitis, Post-contrast FLAIR MRI, lumbar puncture.

1. INTRODUCTION

Meningitis is an infective syndrome affecting the leptomeninges and classically presents with fever, headache & neck rigidity and is detected by cerebrospinal fluid analysis via Lumbar puncture [1]. Acute inflammation of leptomeninges is caused by bacteria known as acute bacterial meningitis (ABM) [2]. Acute bacterial meningitis (ABM) remains an important cause of pediatric disease and death in poor income countries .In more than 90% of cases Haemophilus Influenzae type b and Streptococcus Pneumonia are the causative agents of ABM in Pakistan [3].Approximatley 27.3 % of the children with acute bacterial meningitis rescue with crucial morbidity and approximately 23.7 % of the children are unable to survive according to a study performed by Olson D, et al. [4].

If not suspected, promptly diagnosed, and managed rapidly meningitis continues to be a salient disease throughout the world and it can be a lethal emergency [5,6]. Death rates for untreated tuberculous meningitis are 100% [7]. Rapid and explicit diagnosis and suitable treatment of bacterial meningitis in children remains an important challenge, as indicated by the continued high case-fatality rates of the disease worldwide [8].

Cerebrospinal fluid (CSF) assessment is the most vital phase of the laboratory diagnosis of meningitis. Examination of the CSF abnormalities generated by bacterial, mycobacterial and fungal infections may significantly assist for diagnosis and direct primary therapy [9].Computed tomography (CT) and magnetic resonance imaging (MRI) play cardinal roles in detecting brain infections but magnetic resonance imaging is more prompt. Therefore, it is proposed as a first line diagnostic tool in brain infections [10]. Fluid-attenuated inversion recovery (FLAIR) is a unique inversion recovery pulse sequence has a long repetition time (TR), echo time (TE) and an inversion time (TI) that efficiently void signals from the cerebrospinal fluid (CSF) [11].

Post Contrast FLAIR imaging as taken a lead over Post contrast T1-weighted imaging in visualization of infective leptomeningeal disease because there is very less to no vascular enhancement in

Post Contrast FLAIR Images as compared to Post contrast T1 weighted MR images [12]. In the last decade, for assessment of leptomeningeal diseases post contrast FLAIR (PCFLAIR) has come into view as effective sequence. Meningeal enhancement easily noticeable on post contrast FLAIR images as compare to T1 weighted images, due to nullification of CSF signals and some degree of T1 relaxivity effect [13]. In a study done by Aneel kumar et al, for the diagnosis of meningitis, the sensitivity of Post-Contrast FLAIR sequence was 96% and specificity 85.71%, whereas the sensitivity of Post-Contrast T1 weighted sequence was 68% and specificity 85.71%14. This gives us a clue regarding higher accuracy of Post Contrast FLAIR MR Imaging as compared to conventional Post Contrast T1Weighted imaging.

As noted the morbidity &mortality rates in children experiencing meningitis is much raised and currently in our clinical practice pre and post contrast computed tomography is performed for the detection of meningitis [4]. This exposes the children to a high dose of neutron radiation. The basis of this study is to determine and demonstrate the diagnostic accuracy of Post Contrast FLAIR MR Imaging for meningitis in pediatric population. If the accuracy comes high the significance of Post Contrast FLAIR MR Imaging in early diagnosis of meningitis would be established.

Rationale of this study was to establish radiation free technique for early diagnosis of this dangerous condition in children leading to immediate starting of treatment and a better patient prognosis.

2. Patients & Methods

The cross-sectional study was conducted from April to September 2017 in department of radiology Nishtar Hospital, Multan. 100 patients with age 02 to 12 years of either gender were selected which were presented with fever > 101oF, neck rigidity and altered mental status (GCS 13) referred from Emergency department and Neuroclinics of hospital. Patients who were already on antibiotics were excluded from the study. The approval of institutional research & ethical committee and informed consent was taken prior to commencement of the study. The sample size was calculated by using sensitivity and specificity of MR Flair sequence imaging for diagnosis of meningitis. The sample was collected through nonprobability consecutive sampling technique. MRI brain was performed from vertex to the base of skull on PhilipsTM Achieva 1.5 tesla (T) MR System. After the acquisition of routine pre contrast sequences, intravenous gadolinium contrast was administered. Conventional post contrast T1 weighted images were followed by post contrast FLAIR images. Following MRI exam, CSF was collected via Lumbar Puncture (LP) of each patient. The lab results of LP were the "reference standard" against which MRI findings was compared. The post contrast FLAIR images obtained were evaluated by experienced radiologists (with experience of more than 5 years) to determine the abnormal high leptomeningeal signals. The findings of MR imaging and LP of each patient were then compared taking later as the Gold Standard.

The whole study was statistically evaluated to determine the sensitivity and specificity of MR Flair sequence in diagnosing Meningitis taking Lumbar puncture findings as gold standard.

Patients Data was entered and analyzed by using Statistical Package for Social Sciences (SPSS 21.0). Frequency and percentage was computed for qualitative variables i.e. presenting complains, History of Presenting illness, MR Flair sequence findings and Lumbar Puncture findings. Mean ± SD was calculated for quantitative variable i.e. age. With Lumbar Puncture findings as gold standard; the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of MR Flair sequence findings was calculated.

3. Results

Our study recruited a total of 100 children with signs and symptoms of meningitis. Of these 100 children, 62 (62 %) were boys and 38 (38 %) were girls.

Mean age of our study cases was 3.92 ± 2.12 years (with minimum age of our study cases was 2 years while maximum age was 11 years), 42 (42 %) belonged to rural areas while 58 (58 %) belonged to urban areas, 53 (53 %) were poor and 47 (47 %) were from middle income families. Mean GCS was 10.23 ± 3.18 and 76 (76 %) had GCS ranging from 8 – 13. Mean duration of symptoms was 54.87 ± 18.97 hours and most of our study cases i.e. 66 (66 %) had duration of symptoms more than 36 hours.

Post contrast FLAIR MRI findings were positive in 48 (48 %) while negative in 52 (52 %) while lumbar puncture revealed positive findings in 51 (51 %) while negative in 49 (49 %).

Sensitivity of the post contrast FLAIR MRI was 78.43 % while specificity was 83.67 %, diagnostic accuracy was 81.00 %, positive predictive value was 83.33 % and negative predictive value was 78.84 % (Table No. 1-2).

Table 1: Cross-tabulation of post contrast FLAIR MRI findings versus lumbar puncture findings (n= 100).

Post contrast FLAIR MRI findings	**Lumbar Puncture findings**	
	Positive (n = 51)	**Negative** (n = 49)
Positive (n = 48)	40 (TP)	08 (FP)
Negative (n = 52)	11 (FN)	41 (TN)
Total	**100**	

$$\textbf{Sensitivity} = \frac{\text{True Positive}}{\text{True Positive + False Negative}} \times 100 = \frac{40}{40 + 11} \times 100 = 78.43\ \%$$

$$\textbf{Specificity} = \frac{\text{True Negative}}{\text{True Negative + False Positive}} \times 100 = \frac{41}{41 + 8} \times 100 = 83.67\ \%$$

$$\textbf{Diagnostic Accuracy} = \frac{\text{True Positive + True Negative}}{\text{True Positive + True Negative + False Positive + False Negative}} \times 100 = \frac{40 + 41}{40+41+11+8} \times 100 = 81.00\ \%$$

$$\textbf{PPV} = \frac{\text{True Positive}}{\text{True Positive + False Positive}} \times 100 = 83.33\ \%$$

$$\textbf{NPV} = \frac{\text{True Negative}}{\text{False Negative + True Negative}} \times 100 = 78.84\ \%$$

4. DISCUSSION

Infants with meningitis often present with nonspecific findings of fever, poor feeding, lethargy (or decreased interaction with caregivers), vomiting and irritability. They sometimes have a rash. Inconsolable crying, prolonged or worsening irritability or progressive lethargy are also important clinical features that may indicate a central nervous system (CNS) focus such as meningitis. Nuchal rigidity is uncommon in infants; however the specific symptoms of meningitis such as headache, nuchal pain and impaired consciousness as well as other nonspecific symptom are seen in older children. Respiratory status and inclusive neurological examinations is performed to diagnose any focal neurological signs, postural abnormalities, cranial nerve involvement and evaluation of level of alertness [15].

Full investigations of patients should be performed, For CSF analysis (cell count, glucose and protein levels spinal centeses is done, microbiological culture and molecular detection of bacterial DNA [if clinical suspicion is high and bacterial cultures are negative] and viral studies where appropriate, as well as inspection for specific testing for tuberculosis in high-risk children) is mandatory for the definitive diagnosis of meningitis. A Lumber puncture (LP) should always be attempted unless there are contra-indications. Molecular investigations may still be beneficial even if antimicrobials have been administered, and other options should be discussed with a pathologist. Contraindications to spinal tap include coagulopathy, cutaneous lesions at the puncture site, and findings of brain herniation or shock. If there is papilledema, the presence of focal neurological signs, decreased level of consciousness or coma, a LP should be deferred until imaging (a contrast-enhanced computed tomography and/or magnetic resonance imaging of the head) is performed and the risk of potential herniation is ruled out. Lumber puncture complication like herniation is rare in meningitis in the absence of focal CNS lesions [15].

Our study included a total of 100 children meeting criteria of our study. Of these 100 children, 62 (62 %) were boys and 38 (38 %) were girls. A study organized by Bari et al from Lahore also reported male gender predominance with 63.8 % which is close to our study results [16]. Fayyaz et al from Karachi has reported 69.8 % male gender predominance which is close to our study results [17]. Khan et al from Rawalpindi has also reported male gender preponderance with 58 % boys with meningitis which is in compliance with our study results [18]. Sallam et al. from Yemen has also documented 69 % male gender predominance which is close to our study results [19]. A study conducted by Rashid et al has reported 62 % male gender predominance which is in compliance with our study results [20]. A study conducted by Asghar et al from Rawalpindi has also reported 60 % male gender dominance which is close to our study results [21].

Mean age of our study cases was 3.92 ± 2.12 years (with minimum age of our study cases was 2 years while maximum age was 11 years). Our study results have suggested that majority of our study cases i.e. 82 (82 %) were aged less than 5 years. A study operated by Bari et al from Lahore reported 11.3 ± 12 months which is less than that of our study results, the reason for this difference is due to our inclusion criteria as we only included patients having ages more than 2 years [16]. Tajdin et al from Lahore has also reported similar conclusions 22. Fayyaz et al from Karachi has reported 4.8 ± 4.14 years mean age which is close to our study results [17]. Khan et al from Rawalpindi has also reported 6 years mean age which is close to our study results [18]. Sallam et al from Yemen has also documented 4.1 ± 0.71 years mean age which is close to our study results [19]. A study conducted by Rashid et al has reported similar outcomes [20]. A study conducted by Asghar et al from Rawalpindi has also reported mean age was 4.0 ± 3.9 months which is close to our study results [21]. Our study has a limitation in aspect of number of patients. More number of patients may depict more sensitivity and specificity.

Recently, magnetization transfer MRI has been proposed as a useful tool in the diagnosis of tuberculous meningitis. Visibility of the meninges on precontrast T1-weighted magnetization transfer images may be considered highly suggestive of tuberculous meningitis [23].

Post contrast FLAIR MRI findings were positive in 48 (48 %) while negative in 52 (52 %) while lumbar puncture revealed positive findings in 51 (51 %) while negative in 49 (49 %). Sensitivity of the post contrast FLAIR MRI was 78.43 % while specificity was 83.67 %, diagnostic accuracy was 81.00 %, positive predictive value was 83.33 % and negative predictive value was 78.84 %. In a study done by Aneel kumar et al for the diagnosis of meningitis, the sensitivity of Post-Contrast FLAIR sequence was 96% and specificity 85.71% which is in compliance with our study results [14].

5. CONCLUSION

Post contrast FLAIR magnetic resonance imaging is an authentic, safe and potent detective tool for the diagnosis of meningitis among suspected children. High sensitivity, specificity and diagnostic accuracy has been observed in our study, so our study results support post-contrast FLAIR MRI in the diagnosis of meningitis among targeted population.

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Citation: Muhammad Asim Ali Qureshi, Ameet Jesrani, Kousar Magsi, Seema Nayab "Diagnostic Accuracy of Post Contrast Magnetic Resonance Imaging for Meningitis Taking Lumbar Puncture as Gold Standard. Experience at Nishtar Hospital-Multan" Tryaksh International Journal of Medical and Clinical Case Studies (TIJMCCS)" Volume 1, Issue 1, 2020, pp. 1-4.

Received Date: 21st July 2020; **Accepted Date:** 25th July 2020; **Published Date:** 28th July 2020