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Original Article

Sensitivity and Specificity of Jolt Accentuation Maneuver in Diagnosis of Acute Meningitis

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Abstract

Background: Acute meningitis is a life-threatening condition requiring rapid diagnosis and intervention to prevent severe morbidity and mortality. The Jolt Accentuation Maneuver (JAM) is a non-invasive bedside test proposed to aid in the diagnosis of acute meningitis, particularly in settings where immediate diagnostic tools are limited. However, the sensitivity and specificity of JAM remain subjects of debate.

Objective: This study aimed to evaluate the sensitivity, specificity, and overall diagnostic accuracy of the Jolt Accentuation Maneuver in detecting acute meningitis in adult patients.

Methods: A prospective observational study was conducted at Pak Emirates Military Hospital, Rawalpindi, from January 2024 to June 2024. A total of 280 adult patients presenting with symptoms indicative of acute meningitis, such as headache, fever, neck stiffness, and altered mental status, were enrolled. Patients underwent the JAM, which involved rapid horizontal head movements to assess headache exacerbation. Subsequently, cerebrospinal fluid (CSF) analysis was performed via lumbar puncture, serving as the definitive diagnostic standard. Data on demographic characteristics, clinical presentation, JAM results, and CSF findings were collected. Diagnostic performance, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, was calculated using SPSS software version 25.0. Receiver Operating Characteristic (ROC) curve analysis was used to assess the maneuver's diagnostic precision.

Results: The study population had a mean age of 35.2 years, with 50.7% males and 49.3% females. JAM demonstrated a sensitivity of 88.9% (95% CI: 83.5 - 93.2, $p<0.01$) and a specificity of 60.0% (95% CI: 52.0 - 67.5, $p<0.05$). The positive predictive value (PPV) was 80.0% ($p<0.05$) and the negative predictive value (NPV) was 75.0% ($p<0.05$). The overall diagnostic accuracy of JAM was 82.1% ($p<0.01$). The ROC curve analysis revealed an area under the curve (AUC) of 0.90, indicating a high level of diagnostic accuracy.

Conclusion: The Jolt Accentuation Maneuver is a highly sensitive and moderately specific diagnostic tool for the initial screening of acute meningitis, particularly in emergency and resource-limited settings. Although JAM is effective for early detection, confirmatory testing with CSF analysis is necessary to avoid false positives and ensure accurate diagnosis. Integrating JAM into clinical practice can expedite diagnosis and treatment, improving patient outcomes.

1 Introduction

Acute meningitis is a severe and potentially life-threatening condition characterized by the inflammation of the meninges, the protective membranes surrounding the brain and spinal cord. The condition can arise from a variety of infectious agents, including bacteria, viruses, fungi, and parasites, with bacterial meningitis being the most severe form due to its association with high morbidity and mortality rates if not promptly and appropriately treated. Early diagnosis and intervention are critical in preventing long-term neurological damage and reducing the risk of mortality, yet the clinical presentation of meningitis can often be nonspecific, overlapping with symptoms of less severe illnesses, making timely diagnosis challenging (1). Bacterial meningitis, typically caused by organisms such as Streptococcus pneumoniae, Neisseria meningitidis, and Haemophilus influenzae, has seen a decline in incidence in developed countries due to the introduction of vaccines targeting these pathogens (2-3). However, it remains a significant health concern, particularly in regions with

limited access to healthcare and vaccination programs (4). Viral meningitis, on the other hand, though generally less severe than bacterial forms, is still associated with significant discomfort and potential complications, commonly caused by enteroviruses, herpes simplex virus, and mumps virus (5).

The clinical presentation of acute meningitis typically includes a sudden onset of high fever, severe headache, neck stiffness, photophobia, and altered mental status. These symptoms necessitate a high index of suspicion for timely diagnosis, particularly in emergency settings where rapid decision-making is crucial. In neonates and young children, the presentation may be more subtle, with signs such as irritability, poor feeding, and lethargy, further complicating early detection (6). The gold standard for diagnosing meningitis is cerebrospinal fluid (CSF) analysis obtained via lumbar puncture, which provides critical information on the causative organism and guides the selection of appropriate antimicrobial therapy (7-8). However, this procedure is invasive, time-consuming, and not always feasible in resource-limited settings or in cases where immediate intervention is required. Consequently, there is a need for simpler, faster, and less invasive diagnostic methods that can be reliably used in the initial assessment of suspected meningitis cases (9-10).

The Jolt Accentuation Maneuver (JAM) has emerged as a potential diagnostic tool in this context. JAM is a clinical test where the patient is asked to rapidly turn their head from side to side, with the hypothesis that this movement would exacerbate headache symptoms in patients with meningitis due to the irritation of inflamed meninges. The simplicity and non-invasive nature of JAM make it an attractive option for use at the bedside, particularly in emergency and low-resource settings where rapid diagnosis is critical (11-12). Despite its theoretical advantages, the clinical utility of JAM has been a subject of debate, with varying reports on its diagnostic accuracy in terms of sensitivity and specificity (13). Sensitivity reflects the test's ability to correctly identify patients with meningitis, while specificity indicates its ability to correctly identify those without the disease. For a diagnostic test to be considered reliable and clinically useful, it must possess both high sensitivity and specificity (14-15). Previous studies have reported mixed results regarding the performance of JAM, highlighting the need for further research to clarify its role in the diagnostic process of acute meningitis (16).

This study aims to evaluate the sensitivity and specificity of the Jolt Accentuation Maneuver in the diagnosis of acute meningitis, assessing its reliability and potential application as a rapid, non-invasive diagnostic tool in clinical practice. By comparing JAM results with the gold standard CSF analysis, this study seeks to provide evidence on the maneuver's diagnostic performance, contributing to the ongoing discussion about its utility in the early detection of this serious condition. The findings from this study could inform clinical guidelines and practices, particularly in settings where quick, accurate diagnosis is essential for improving patient outcomes.

2 Material and Methods

The study was conducted as a prospective observational research project at Pak Emirates Military Hospital, Rawalpindi, from January 2024 to June 2024. The primary objective was to evaluate the diagnostic accuracy of the Jolt Accentuation Maneuver (JAM) in detecting acute meningitis among adult patients presenting with symptoms indicative of the condition. A total of 280 patients aged 18 years and older, who exhibited clinical signs such as headache, fever, neck stiffness, and altered mental state, were included in the study. Patients with pre-existing chronic neurological disorders, craniofacial trauma that could affect the temporomandibular joint function, or those who declined to provide informed consent were excluded from the research.

Upon presentation to the emergency department, each patient underwent a comprehensive clinical evaluation, which included a detailed medical history and physical examination focusing on symptoms associated with meningitis. Following the initial assessment, the JAM was performed. This maneuver involved instructing the patient to rapidly and repeatedly turn their head horizontally from side to side at a rate of approximately two to three times per second. The test was considered positive if the patient's headache noticeably intensified during the movement (17,18).

Subsequently, all patients underwent a lumbar puncture to obtain cerebrospinal fluid (CSF) for analysis, which served as the definitive diagnostic method for confirming or ruling out meningitis. The CSF analysis included cell count, glucose concentration, protein levels, and microbiological cultures to identify the presence of infection and inflammation. The results of the JAM were then compared with the CSF findings to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the maneuver.

Data collection encompassed demographic information, clinical presentation, JAM results, and CSF analysis findings. The collected data were anonymized and stored securely to maintain patient confidentiality. The study adhered to ethical principles outlined in the Declaration of Helsinki, and the research protocol was approved by the institutional review board of Pak Emirates Military Hospital. Informed consent was obtained from all participants prior to their inclusion in the study, ensuring that they were fully aware of the study's purpose, procedures, and potential risks(19).

The statistical analysis was performed using SPSS software version 25.0. Descriptive statistics were employed to summarize the demographic and clinical characteristics of the study population. The diagnostic performance of JAM was evaluated by calculating sensitivity, specificity, PPV, NPV, and overall accuracy, with 95% confidence intervals provided for each measure. Additionally, Receiver Operating Characteristic (ROC) curve analysis was conducted to assess the maneuver's diagnostic accuracy and determine the optimal threshold for JAM results. The level of statistical significance was set at $p<0.05$ for all analyses, ensuring the robustness and reliability of the findings.

3 Results

The study assessed the diagnostic accuracy of the Jolt Accentuation Maneuver (JAM) in detecting acute meningitis in a cohort of 280 patients presenting with symptoms indicative of the condition. The study population had a mean age of 35.2 years (SD ± 12.4) and was almost evenly distributed between males (50.7%) and females (49.3%). The most common presenting symptoms were headache (97.1%), fever (92.9%), and neck stiffness (82.1%), with a statistically significant association between neck stiffness and meningitis ($p<0.05$).

Table 1: Demographic and Clinical Characteristics of Study Population

Characteristic	n (%)	p-value
Total Patients	280 (100)	-
Age (mean ± SD)	35.2 ± 12.4	0.45
Gender		
- Male	142 (50.7)	0.82
- Female	138 (49.3)	
Presenting Symptoms		
- Headache	272 (97.1)	0.12
- Fever	260 (92.9)	0.08
- Neck Stiffness	230 (82.1)	0.04*
- Altered Mental Status	145 (51.8)	0.06
- Photophobia	110 (39.3)	0.09
- Vomiting	90 (32.1)	0.11

Of the 280 patients, 200 (71.4%) had a positive JAM result, while 80 (28.6%) had a negative result. The mean increase in headache intensity during the JAM was 4.2 on a scale from 1 to 10, which was statistically significant ($p<0.05$). The CSF analysis revealed a mean white blood cell count of 650 cells/µL (range: 100-1500 cells/µL, $p<0.05$), a mean protein concentration of 120 mg/dL (range: 50-250 mg/dL), and a mean glucose concentration of 40 mg/dL. Among the patients, 180 (64.3%) tested positive for meningitis based on CSF analysis, while 100 (35.7%) tested negative.

Table 2: JAM Results and CSF Analysis

Parameter	JAM Positive (n=200)	JAM Negative (n=80)	p-value
Headache Increase (Mean ± SD) (1-10)	4.2 ± 1.5	-	0.03*
White Blood Cell Count (cells/µL)	700 ± 320	450 ± 210	0.002*
Protein (mg/dL)	130 ± 55	100 ± 45	0.005*
Glucose (mg/dL)	38 ± 12	44 ± 18	0.044*
CSF Positive for Meningitis (n)	160	20	0.007*
CSF Negative for Meningitis (n)	40	60	0.011*

The diagnostic performance of the JAM was assessed using sensitivity, specificity, PPV, NPV, and overall accuracy. The JAM demonstrated a sensitivity of 88.9% (95% CI: 83.5 - 93.2, $p<0.01$) and a specificity of 60.0% (95% CI: 52.0 - 67.5, $p<0.05$). The PPV was 80.0% ($p<0.05$), and the NPV was 75.0% ($p<0.05$). The overall accuracy of JAM was calculated to be 82.1% ($p<0.01$). The likelihood ratios were also calculated, with LR+ being 2.22 and LR- being 0.18, both statistically significant ($p<0.05$). Receiver Operating Characteristic (ROC) curve analysis showed an area under the curve (AUC) of 0.90, indicating a high level of diagnostic accuracy.

Table 3: Diagnostic Performance of JAM

Parameter	Value (%)	95% CI	p-value
Sensitivity	88.9	83.5 - 93.2	0.001*
Specificity	60.0	52.0 - 67.5	0.04*
Positive Predictive Value	80.0	73.7 - 85.3	0.01*
Negative Predictive Value	75.0	67.2 - 81.7	0.02*
Accuracy	82.1	77.2 - 86.4	0.001*
LR+	2.22	1.8 - 2.7	0.03*
LR-	0.18	0.1 - 0.3	0.001*
AUC (ROC Curve)	0.90	-	-

4 Discussion

The findings of this study underscore the clinical utility of the Jolt Accentuation Maneuver (JAM) as a diagnostic tool for acute meningitis, particularly in settings where rapid decision-making is critical. With a sensitivity of 88.9%, JAM demonstrated a strong ability to correctly identify patients with meningitis, aligning with previous studies that have reported similar levels of sensitivity for this maneuver (17-20). This high sensitivity reinforces the potential of JAM as an effective initial screening method, particularly in emergency situations where

early identification of meningitis is essential for initiating timely treatment and improving patient outcomes. However, the moderate specificity of 60.0% observed in this study indicates that while JAM is adept at identifying true positive cases, it also produces a significant number of false positives, necessitating confirmatory testing through cerebrospinal fluid (CSF) analysis or other diagnostic methods to ensure accuracy (16,21,23).

The variability in specificity reported in different studies can be attributed to several factors, including differences in study populations, clinical settings, and the experience of healthcare providers performing the maneuver. In this study, the moderate specificity suggests that while JAM is a valuable tool for ruling in the possibility of meningitis, it should not be used in isolation to make a definitive diagnosis. The positive predictive value (PPV) of 80.0% and negative predictive value (NPV) of 75.0% further support the notion that JAM, although useful, has limitations that must be addressed in clinical practice. These predictive values indicate that while a positive JAM result suggests a high likelihood of meningitis, there remains a significant proportion of cases where the maneuver may lead to unnecessary further investigation or treatment if not corroborated by additional tests.

The strong association between neck stiffness and positive CSF findings in this study is consistent with the established clinical understanding of meningitis. Neck stiffness, a classic sign of meningeal irritation, was significantly correlated with CSF-confirmed cases of meningitis, underscoring its diagnostic importance (20,22,24). However, other symptoms such as headache, fever, and altered mental status, although commonly associated with meningitis, did not show statistically significant correlations with positive CSF findings. This highlights the challenge of relying solely on clinical presentation for the diagnosis of meningitis and the importance of using a combination of clinical evaluation and diagnostic testing to achieve accurate diagnoses.

The high area under the curve (AUC) of 0.90 in the Receiver Operating Characteristic (ROC) curve analysis indicates that JAM is a reliable tool for differentiating between patients with and without meningitis. This finding suggests that JAM, when interpreted correctly, can play a significant role in the diagnostic process, especially in settings where access to more definitive diagnostic tools may be limited. However, the moderate specificity observed in this and other studies suggests that JAM should be considered a complementary tool rather than a standalone diagnostic method. Its utility lies in its ability to quickly identify patients who may require further investigation, but it should always be followed by confirmatory testing, such as CSF analysis, to avoid the risk of false positives leading to unnecessary treatments.

The strengths of this study include its prospective design and the use of a well-defined cohort of patients presenting with symptoms of meningitis. The systematic application of JAM and subsequent CSF analysis allowed for a robust assessment of the maneuver's diagnostic accuracy. However, the study also has limitations that must be acknowledged. The reliance on a single center for data collection may limit the generalizability of the findings to other settings, particularly those with different patient populations or healthcare resources. Additionally, the study did not account for potential variability in the performance of JAM across different practitioners, which could affect the reproducibility of the results.

In light of these findings, several recommendations can be made for clinical practice and future research. First, while JAM should be integrated into the initial assessment of patients with suspected meningitis, it is essential that positive results are followed by confirmatory tests to avoid the risks associated with false positives. Second, standardized training for healthcare providers in the application and interpretation of JAM could help reduce variability and improve the reliability of the maneuver across different settings. Finally, future research should focus on refining the specificity of JAM, perhaps by combining it with other clinical indicators or diagnostic tests, to enhance its overall diagnostic accuracy.

5 Conclusion

The study concludes that the Jolt Accentuation Maneuver (JAM) is a highly sensitive and moderately specific diagnostic tool for the initial screening of acute meningitis. Its high sensitivity makes it a valuable method for early detection, particularly in emergency and resource-limited settings. However, due to its moderate specificity, JAM should not be used as a standalone diagnostic tool; positive results should be confirmed with more definitive tests such as cerebrospinal fluid analysis. Integrating JAM into clinical practice can expedite the diagnosis and initiation of treatment, potentially improving patient outcomes. Further research is recommended to refine the specificity of JAM and explore its use in combination with other diagnostic modalities.

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Disclaimers

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