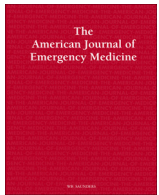




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Original Contribution

Jolt accentuation of headache and other clinical signs: poor predictors of meningitis in adults ☆☆☆

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ABSTRACT

Jolt accentuation or exacerbation of a baseline headache with horizontal rotation of the neck is a physical finding believed to assess for meningeal irritation. We conducted a prospective observational study of neurologically intact emergency department (ED) patients undergoing lumbar puncture in 2 inner city academic EDs to validate the sensitivity and specificity of jolt accentuation and to assess the sensitivity and specificity of Kernig sign, Brudzinski sign, and nuchal rigidity, in predicting cerebrospinal fluid (CSF) pleocytosis in individuals being assessed for meningitis. Adult patients 18 years and older undergoing lumbar puncture between 2006 and 2009 were approached for consent. Exclusions included inability to consent and altered mental status. Physicians were asked to answer a questionnaire of physical examination findings before receiving CSF results. The primary outcome was the presence or absence of pleocytosis, defined as greater than or equal to 5 cells/high-power field in the fourth CSF tube. We calculated descriptive statistics and tests of diagnostic accuracy. A total of 230 patients consented for participation and had CSF white blood cell counts recorded. Forty-seven individuals (20%) had pleocytosis. A total of 197 patients had headache and were, hence, eligible for jolt accentuation assessment. For pleocytosis, the sensitivity of jolt accentuation was 21%, Kernig sign was 2%, Brudzinski sign was 2%, and nuchal rigidity was 13%. The specificity of jolt accentuation was 82%, Kernig sign was 97%, Brudzinski sign was 98%, and nuchal rigidity was 80%. Jolt accentuation in our cohort was poorly predictive of pleocytosis and insensitive. The presence of Kernig sign, Brudzinski sign, or nuchal rigidity has moderate positive but no negative predictive value for pleocytosis.

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1. Introduction

1.1. Background

Bacterial meningitis, with an annual incidence of 4 to 6 cases per 100,000 adults in the United States [1] and an overall mortality rate of 20% to 30% [2,3], is considered a medical emergency requiring rapid diagnosis and timely intervention. The criterion standard for diagnosing meningitis is the lumbar puncture (LP), a potentially painful procedure that carries a risk of complications including worsened headache, spinal hematoma, and introduction of infection. Establishing predictive clinical variables that accurately predict the absence of meningitis may allow clinicians to comfortably forego an LP in very low-risk individuals.

Much of what is taught and believed to be predictive regarding the signs and symptoms of meningitis comes from chart review data as well as diagnostic signs developed during a meningococcal epidemic before the discovery of antibiotics, advent of vaccinations, and development of public health measures. The objective of our study was to evaluate the sensitivity and specificity of clinical variables in predicting cerebrospinal fluid (CSF) pleocytosis in neurologically intact individuals undergoing LP for possible meningitis at our 2 affiliated urban emergency departments (EDs). Our secondary objective was to assess the diagnostic accuracy of physicians' clinical suspicion for meningitis. We hypothesized that jolt accentuation and classic signs of meningeal irritation including Kernig sign, Brudzinski sign, and nuchal rigidity are poorly predictive of CSF pleocytosis.

2. Methods

2.1. Study design and setting

We conducted an observational study of neurologically intact adult ED patients undergoing an LP in our 2 inner city academic EDs. St Luke's Hospital and Roosevelt Hospital are affiliated teaching hospitals in Manhattan, New York City, with an emergency medicine residency program and an estimated annual patient census of

☆ Prior presentation: This work has been presented at the American College of Emergency Physicians Scientific Assembly, October 2011, San Francisco, CA, as "Jolt accentuation of headache: sensitive enough for pleocytosis to rule-out need for a lumbar puncture in diagnosing meningitis?" (abstract no. 019).

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approximately 190,000. The study was approved by the St Luke's–Roosevelt Hospital Center Institutional Review Board.

2.2. Selection of participants

A convenience sample of adult patients 18 years and older presenting to either EDs and undergoing LP with the treating physician suspecting meningitis as a potential diagnosis during a 4-year period from January 1, 2006, to December 31, 2009, were considered eligible for the study. Exclusions included inability to provide consent, prisoner status, and alteration in mental status.

2.3. Data collection and processing

Trained research assistants staffed both EDs from 8 AM to midnight on a university-based academic calendar representing approximately 60% of days annually. Research assistants monitored a real-time tracking system for all patients with potentially associated presentations, including headache and fever, and approached treating physicians to inquire about the potential need for an LP. The departmental supply of LP trays was relocated to the research assistant computer kiosk area to ensure catchment. Eligible patients were approached for consent if the treating physician confirmed the absence of exclusion criteria. Following informed consent, assistants asked physicians, typically attending physicians or senior level emergency medicine residents, to fill out a standardized data collection tool recording patient age, sex, symptoms (including headache and fever), clinical signs (including temperature, and presence of Kernig sign, Brudzinski sign, jolt accentuation, nuchal rigidity, vomiting, and rash), and physician suspicion of meningitis after seeing the subject but before performing the LP.

All CSF samples were sent to the laboratory for cell count, glucose level, protein level, and cultures. Data forms were collected from the physicians by the research assistants, who entered all of the data into a Microsoft Excel document. The results of LPs were later extracted from the electronic medical record and recorded in the database.

These data were later reviewed by 2 study investigators; medical record numbers, subject age, CSF analysis and culture results, and date of LP were confirmed through the electronic medical record. The electronic medical record was also interrogated for subject ethnicity.

2.4. Outcome measures and variable definitions

The principal outcome of this study was pleocytosis. We defined *pleocytosis* as CSF white blood cell (WBC) count greater than or equal to 5 cells/high-power field (HPF) in the fourth tube taken from the LP, with a ratio of red blood cells to white blood cells (red blood cell: WBC) less than 700:1. We defined *moderate pleocytosis* as greater than or equal to 100 cells/HPF and *severe pleocytosis* as greater than or equal to 1000 cells/HPF based on prior convention [4,5].

Headache was a subjective symptom. The variable “fever” was a combination of subjective fever, whether a subject reported having or having had a fever, and objective fever as measured in the ED. *Objective fever* was defined as an oral or rectal temperature greater than or equal to 100.4°F.

Jolt accentuation was defined as exacerbation of a baseline headache with horizontal rotation of the neck, 2 to 3 times per second [6]. Other variable definitions were, in the case of “classic” signs of meningeal irritation, based on textbook definitions and reviewed with department physicians at group training sessions and individually before and throughout the study period. A Kernig sign was considered present “if the examiner is unable, because of resistance and hamstring pain, to straighten the patient's leg passively to a position of full knee extension when the patient is lying supine with the hip flexed to a right angle” [7], and Brudzinski sign was considered present “if attempts to flex the neck passively are

accompanied by flexion of the hips” [7]. *Nuchal rigidity* was defined as “discomfort [or pain] on flexion of the neck” [7].

Regarding physician suspicion of meningitis, after interviewing and examining a subject but before performing the LP, the emergency physician was asked for his or her “impression” as to whether the subject did (subjectively judged as 50% or higher probability) or did not (subjectively judged as less than 50% probability) have bacterial meningitis. This outcome was binary.

2.5. Analysis

Statistical data exploration and analysis were conducted by the primary investigator using Stata statistical software (version 10, 2007; StataCorp LP, College Station, TX). We used common descriptive statistics and diagnostic performance tests with 95% confidence intervals.

3. Results

3.1. Characteristics of study participants

Over the 4-year period, 240 subjects were enrolled that met predefined inclusion and exclusion criteria and whose data forms were complete. Data were reviewed by 2 of the primary investigators. Data for 10 subjects were not included in the analysis because CSF WBC counts from the fourth tube were missing. Hence, 230 subjects were included in the final analysis; one of these had values for particular minor variables missing and was included in the analysis accordingly wherever possible.

The average age of enrollees was 40.2 years, and 43.0% were male (Table 1). Forty-seven subjects (20.4%) had pleocytosis, 15 (6.5%) had moderate pleocytosis, and 1 (0.4%) had severe pleocytosis.

3.2. Clinical presentation

One hundred ninety-seven individuals (85.7%) reported headache, and 90 (39.1%) reported fever (Table 2). The 197 subjects who complained of headache were eligible for jolt accentuation assessment, and 229 had physical examination signs recorded. Of subjects presenting with headache, 37 (18.8%) had a positive jolt accentuation test. Of the 229 individuals with recorded physical examination signs, 6 subjects (2.6%) had a positive Kernig sign, 5 (2.2%) had a positive Brudzinski sign, and 43 (18.8%) had nuchal rigidity.

3.3. Pleocytosis and culture-positive meningitis

The prevalence of cultures showing pathogen growth in subjects with CSF pleocytosis was 6%. Three cultures were positive, growing *Neisseria meningitidis*, *Cryptococcus neoformans*, and *Enterovirus*, making the prevalence of culture-positive bacterial meningitis 2%.

Table 1
Demographic characteristics, subjects receiving LP

Characteristics	All patients
Age	
Age (y), mean (range)	40.2 (18–88)
No. of patients ≥ 60 years old (%)	28/230 (12.2%)
Sex	
Male	99/230 (43.0%)
Female	131/230 (57.0%)
Ethnicity	
White	82/230 (35.6%)
Black	70/230 (30.4%)
Hispanic	36/230 (15.7%)
Other/unknown ^a	42/230 (18.3%)

^a Patients who during registration chose not to identify themselves by race.

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