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Brief Report

Absence of jolt accentuation of headache cannot accurately rule out meningitis in adults ☆

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ABSTRACT

Background: Meningitis is a common emergency disease. Signs and symptoms easily observed at the bedside are needed because early recognition of the possibility of meningitis is necessary for the decision to perform lumbar puncture. Jolt accentuation of headache has been reported to be the most sensitive diagnostic test; however, limited articles have reproduced its sensitivity.

Methods: This is a single-center retrospective medical record review between 2007 and 2012. We diagnosed meningitis based on the criterion standard that cerebrospinal fluid total cells is more than 5/mm^3, in accordance with previous studies. All diagnostic and management decisions including Kernig sign, nuchal rigidity, and jolt accentuation of headache were at the physician's discretion. We calculated the sensitivity and specificity of well-known signs and symptoms of meningitis and, especially, compared the efficacy of jolt accentuation of headache with previous studies.

Results: We investigated 531 adult patients who were suspected of meningitis and had lumbar puncture performed. Of these patients, 139 had meningitis. Background characteristics and vital signs were not clinically different between the 2 groups, although classic tetralogy of bacterial meningitis (fever, nuchal rigidity, mental disturbance, and headache) was worth investigated. The sensitivity and specificity of jolt accentuation of headache were 63.9% (95% confidence interval, 51.9%-76.0%) and 43.2% (34.7%-51.6%), respectively.

Conclusion: The absence of jolt accentuation of headache test cannot, on its own, accurately rule out meningitis in adults. Further studies are warranted to reproduce this result and to discover better bedside diagnostic tests.

1. Introduction

Meningitis is a common disease in emergency medicine, and it needs prompt diagnosis. Lumbar puncture is essential for a proper diagnosis, but it is relatively invasive. Thus, signs and symptoms easily taken at bedside are needed [1,2]. Nuchal rigidity, Kernig sign, and Brudzinski sign are traditionally tested when the differential diagnoses include meningitis. These physical examinations have conventionally been thought to be critical to diagnose acute meningitis; however, recent articles have reported its limited reliability [1,3].

Uchihara and Tsukagoshi [4] reported in 1991 that jolt accentuation of headache is the most sensitive diagnostic test; however, limited articles have reproduced its sensitivity and specificity. Waghdhare et al [5] concluded that jolt accentuation has low sensitivity and high specificity in 2010, which is contrary to the original report.

Thus, we calculated and compared with previous studies the sensitivity and specificity of jolt accentuation as well as classical signs and symptoms of meningitis in this single-center, retrospective medical record review.

2. Methods

2.1. Study setting

This study was conducted at Tokyo Metropolitan Tama Medical Center, a 789-bed tertiary care teaching hospital in Tokyo, Japan. The emergency rescue department takes in an average of 38 000 patients per year, including 7200 ambulances. The study was approved by the institutional review board of Tokyo Metropolitan Tama Medical Center with a waiver of informed consent to review retrospective data.

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Table 1
Patient characteristics

	Meningitis (n = 139)	Nonmeningitis (n = 392)	*P*
Age (y)	45.7 (21.0)	49.4 (22.4)	.110[a]
Men/Women	75/64	201/191	.622[b]
Prolonged steroid use	16/139 (12%)	36/392 (9%)	.411[b]
Prolonged immunosuppressant use	1/139 (1%)	16/392 (4%)	.054[b]
Diabetes mellitus	9/139 (6%)	41/392 (10%)	.181[b]
Cancer	13/139 (9%)	24/392 (6%)	.244[b]
GCS	14.0 (2.4)	14.0 (2.1)	.110[a]
RR	19.2 (3.8)	19.4 (4.7)	.805[c]
HR	91.8 (18.3)	96.1 (20.5)	.034[c]
BT	37.8 (1.0)	37.8 (1.2)	.908[c]
sBP	125 (23)	129 (25)	.119[c]

Values are presented as mean (SD). GCS, Glasgow Coma Scale; RR, respiratory rate (in breaths/min); HR, heart rate (in beats/min); BT, body temperature (in °C); sBP, systolic blood pressure (in mm Hg).
[a] Wilcoxon test.
[b] Fisher exact test.
[c] Student *t* test.

Table 2
Signs and symptoms of the patients

	Meningitis (n = 139)	Nonmeningitis (n = 392)	Odds ratio (95% CI)
Headache	104/111 (93.7%)	222/260 (85.4%)	2.62 (1.13-6.06)*
Fever (≥38.0°C)	57/137 (41.6%)	177/380 (46.6%)	0.81 (0.55-1.21)
Fever (≥37.0°C)	111/137 (81.0%)	274/380 (72.1%)	1.65 (1.01-2.68)*
Mental disturbance	44/139 (31.7%)	169/392 (43.1%)	0.61 (0.41-0.92)*
Nuchal rigidity	50/95 (52.6%)	51/197 (25.9%)	3.18 (1.90-5.31)*
Nausea/Vomiting	57/77 (74.0%)	120/202 (59.4%)	1.94 (1.08-3.48)*
Chill/Shivering	17/25 (68.0%)	42/77 (54.5%)	1.77 (0.68-4.59)
Jolt accentuation	39/61 (63.9%)	75/132 (56.8%)	1.35 (0.72-2.51)
Neck flexion	9/21 (42.9%)	14/51 (27.5%)	1.98 (0.69-5.73)
Kernig sign	13/52 (25.0%)	30/121 (24.8%)	1.01 (0.48-2.14)

Values are presented as positive number/number evaluated (percentage).
CI, confidence interval.
* $P < .05$, Fisher exact test.

2.2. Study design

For retrospective medical record review, all emergency department outpatients who had a lumbar puncture performed were screened between January 1, 2007, and November 31, 2012. Patients suspected of other diseases were excluded (tap test, 11; subarachnoid hemorrhage, 7; traumatic tap, 5; Guillain-Barré syndrome, 5; multiple sclerosis, 3; insufficient medical record, 6; other examination such as HIV, 5). Five hundred thirty-one patients (age, ≥15 years; 276 men and 255 women; average age, 48.4 years) were included in this study, of which 139 patients were diagnosed as having meningitis. We diagnosed meningitis based on the criterion standard that cerebrospinal fluid (CSF) total cells were more than 5/mm^3, in accordance with previous studies [3–5].

2.3. History taking and physical examination

All clinical information including background of the patients (prolonged steroid and/or immunosuppressant use preceding examination, history of diabetes mellitus, and history of cancer), history of present illness and presence/absence of jolt accentuation, nuchal rigidity, neck flexion, and Kernig sign was gathered and recorded by an emergency physician. Mental status was assessed mainly by Glasgow Coma Scale. We also interpreted patients as having altered mental status based on medical records [6]. All diagnostic and management decisions were at the physician's discretion. We retrospectively investigated whether there were certain signs and symptoms or not. We excluded a case from analysis when the finding was not recorded in the medical records.

2.4. Data analysis

The data collected in Microsoft Excel (2010) (Redmond, WA) were imported to JMP 10 software for statistical analysis. Fisher exact test, Wilcoxon test, and Student *t* test were performed, and $P < .05$ was considered statistically significant. On Table 1, mean (standard deviation) was used. in Table 3, we performed subclass analysis for patients with no mental disturbance and patients with no mental disturbance with fever (temperature ≥37°C) and headache.

3. Results

Among the meningitis group, there were 10 bacterial meningitides (positive CSF culture or positive Gram staining), 119 viral meningitides, 5 tuberculous meningitides, 4 carcinomatous meningitides, and 1 fungal meningitides. Tuberculous, carcinomatous, and fungal meningitides were diagnosed by its clinical presentation and compatible laboratory data.

Patient characteristics are shown in Table 1. Almost all backgrounds of the patients were not significantly different. The heart rate of the meningitis group (91.8/min ± 18.3/min) was significantly lower than that of the nonmeningitis group (96.1/min ± 20.5/min).

Signs and symptoms of the patients are shown in Table 2. It presents positive finding/number evaluated (percentage). Sensitivity is shown in the meningitis column, and specificity is easily calculated from the percentage in the nonmeningitis column. Headache, fever (≥37°C), mental disturbance, nuchal rigidity, and nausea/vomiting had statistically significant differences between meningitis and nonmeningitis.

We also compared the sensitivity and specificity of jolt accentuation with previous reports and performed subclass analysis in Table 3 [4,5,7,8]. One hundred ninety-three patients (61 meningitides and 132 nonmeningitides) were tested for jolt accentuation, and 39 of 61 and 75 of 132 had a positive finding. The sensitivity and specificity of jolt accentuation of headache were 63.9% (51.9%-76.0%) and 43.2% (34.7%-51.6%; 95% confidence interval; not significant), respectively. Among patients without mental disturbance (49 meningitides and 104 nonmeningitides), sensitivity and specificity were 67.3% (54.2%-80.5%) and 36.5% (27.3%-45.8%; not significant). Among patients without mental disturbance whose temperature is equal to or more than 37°C with headache (38 in the meningitides group and 75 in the nonmeningitides group), sensitivity and specificity were 78.9% (66.0%-91.9%) and 32.0% (21.4%-42.6%; not significant).

4. Discussion

Meningitis must be promptly diagnosed, and signs and symptoms easily taken at the bedside are needed because early recognition of the possibility of meningitis is essential for the decision to perform lumbar puncture, which has definite diagnostic power.

Classic triad of acute meningitis is fever, neck stiffness, and an altered mental status. However, less than two-thirds of patients present with all 3 clinical findings, whereas it has been reported that the complete absence of the triad virtually eliminates the diagnosis of meningitis [1]. Tetralogy of acute meningitis consists of the aforementioned triad and headache. In this retrospective study, not all patients were questioned for each of these symptoms; thus, we were not able to concisely reproduce this thesis. However, patients with bacterial meningitis were positive for at least 1 of the triad and at least 2 of the tetralogy. Although we did not find any statistical significance between the meningitis group and the nonmeningitis group, it is worth asking whether patients have these symptoms or not.

Table 3
Comparison of sensitivity and specificity of jolt accentuation of headache

	Patient	Characteristics	Sn	Sp	LR+	LR−	Odds ratio (95% CI)	Criteria
Uchihara and Tsukagoshi [4] (original article of jolt accentuation)	54 (34/20)	Viral 28 Bacterial 1 Tuberculous 1 Others 4	97%	60%	2.4	0.05		CSF WBC >5/μL
Nakae and Kuroiwa [7] (Japanese)	44 (19/25)	Viral 15 Bacterial 4	42%	56%	0.96	1.03		CSF
Aminzadeh and Roudgari [8]	14	Unknown	100%	72%	1	0		Pleocytosis
Waghdhare et al [5]	190 (99/91)	Viral 62 Bacterial 7 Tuberculous 30	6%	99%	5.52	0.95		CSF WBC >5/μL
This study	193 (61/132)	Viral 56 Bacterial 1 Tuberculous 1 Carcinomatous 3	63.9% (39/61; 51.9%-76.0%)	43.2% (75/132; 34.7-%51.6%)	1.12	0.84	1.35 (0.72-2.51)	CSF WBC >15/3μL
No mental disturbance	153 (49/104)	Viral 48 Bacterial 0 Carcinomatous 1	67.3% (33/49; 54.2%-80.5%)	36.5% (66/104; 27.3%-45.8%)	1.06	0.89	1.19 (0.58-2.44)	
No mental disturbance + fever ≥37°C + headache	113 (38/75)	Viral 38 Bacterial 0	78.9% (30/38; 66.0%-91.9%)	32.0% (51/75; 21.4%-42.6%)	1.16	0.66	1.76 (0.70-4.42)	

Patient, number evaluated for jolt accentuation (meningitis/nonmeningitis); characteristics, diagnosis of meningitis group; Sn, sensitivity; Sp, specificity (positive number/number evaluated; 95% CI); CI, confidence interval; LR+/−: positive/negative likelihood ratio; criteria, criterion standard of meningitis; no mental disturbance, scores of Japan Coma Scale of 0 and Glasgow Coma Scale of 15.

Although physical examination such as Kernig sign, Brudzinski sign, and nuchal rigidity has conventionally been thought to be critical to diagnose acute meningitis, recent articles report its limited reliability [1,3].

Jolt accentuation of headache was first reported by Uchihara and Tsukagoshi [4] as the most sensitive examination of CSF pleocytosis in 1991, and its efficacy was introduced and noted in the rational clinical examination series in *JAMA* in 1999 [1]. Sensitivity and specificity were 97% and 60%, respectively, in the original article; however, only 3 articles (2 English articles [5,8] and 1 Japanese article [7]) have reassessed the sensitivity and specificity with results contrary to the original (Table 3). In only 1 English article from Japan, jolt accentuation was used as a diagnostic test, whose sensitivity was 87.5% (specificity was not assessed) [9]. However, it dealt with an outbreak of aseptic meningitis caused by echovirus 30 in a high school baseball club, and the patients' background is different from the other articles. Waghdhare et al prospectively investigated 190 patients and concluded that sensitivity and specificity were 6% and 92%. Of note, there were 30 tuberculous in 99 meningitis cases [4]. Thus, it is possible that this difference is partly because prevalence, causative pathogens, and patients' background are different depending on the region. Our hospital and Asahi General Hospital, which was the hospital Uchihara and Tsukagoshi [4] preformed their study, are both in Tokyo, and most factors are likely to be similar, except the period in which the patients were examined and treated. Thus, we reassessed the reliability of jolt accentuation of headache and also investigated whether background and fundamental vital signs contribute to the diagnosis.

As we have shown above, our study suggests that the characteristics of patients are not clinically critical to diagnose acute meningitis. Only heart rate was significantly different, but it is not clinically useful because of its large SD. Unexpectedly, mental disturbance decreased the possibility of acute meningitis. This seems mainly because patients with infection admitted to our hospital often undergo lumbar puncture to rule out meningitis concisely even if meningitis is not primarily suspected.

Similar to recent reports, sensitivity and specificity of jolt accentuation of headache were 63.9% and 43.2 % in our cohort. We also performed subclass analysis because patients with mental disturbance may possibly have a difficulty in replying their pain accentuation. Of 153 patients without mental disturbance, sensitivity and specificity were still 67.3% and 36.5%. Uchihara and Tsukagoshi investigated patients with no mental disturbance, fever (>37°C), and headache [4]. According to their inclusion criteria, sensitivity and specificity were 78.9% and 32.0%. Our study thus suggests that the absence of jolt accentuation of headache cannot accurately rule out meningitis.

Our study is the first to reassess jolt accentuation of headache from Japan in an English journal but has several limitations. A single-center, retrospective medical record review has little power to construct strong evidence, and we, furthermore, excluded cases without sufficient information regarding the results of these physical examinations on the medical record. In the original article, jolt accentuation of headache was all examined by 1 person, but in this study, descriptions were not explicitly given to physicians. Thus, the manner in which these signs were evaluated was not standardized. However, these physical examinations are not difficult to learn, and this study was designed to reflect and to clarify the diagnostic reliability in the actual emergency rescue department setting.

Our study suggests again that the classical meningeal sign and jolt accentuation of headache has limited reliability in diagnosing acute meningitis. Compared with 20 years ago, several broad-spectrum antibiotics, pain killers, and immunosuppressive drugs are used in clinical practice. We were not able to investigate the effect of antibiotics and pain killers in this article. Further prospective studies are needed and are requested to assess these factors.

5. Conclusion

We investigated the reliability of signs and symptoms of meningitis, especially jolt accentuation of headache. Our study suggests that the absence of jolt accentuation of headache cannot, in itself, accurately rule out meningitis. We recommend that lumbar puncture is judiciously performed when the differential diagnoses include meningitis. Further studies are desired to reproduce these results and to discover better bedside diagnostic tests.

6. Declaration

We investigated the same cohort in another article. However, the subjects of the articles are independent of the other.

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