

ORIGINAL

Is lumbar puncture mandatory in febrile infants with a bulging fontanelle?

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Abstract

Introduction: Bacterial meningitis is a cause of fever and bulging fontanelle associated with high morbidity and mortality. Therefore, clinical guidelines recommend performing a lumbar puncture in patients with this clinical presentation. The aim of this study was to determine whether, in certain selected cases, performing a lumbar puncture might not be mandatory.

Material and methods: After conducting a retrospective review of patients evaluated at our center for bulging fontanelle and febrile syndrome, we performed a literature review using PubMed. The search criteria included (“bulging fontanelle” OR “bulging fontanel”) AND (“fever” OR “febrile”), and the main results from the selected studies were collected.

Results: We present the clinical characteristics, complementary tests, and outcomes of five infants with febrile syndrome and bulging fontanelle. In our series, respiratory viruses were the main etiology. The literature review included a total of 9 articles. Two studies concluded that the bulging fontanelle warrants a lumbar puncture; however, these studies were conducted in areas with high morbidity and mortality rates from bacterial meningitis. The remaining studies concluded that there is no single pathognomonic sign. They emphasized the importance of evaluating a constellation of signs, with particular attention to the child’s overall appearance, to guide management decisions.

Conclusions: In our setting, an isolated bulging fontanelle in a well-appearing febrile infant seems to have low sensitivity, specificity, and positive predictive value for the detection of meningitis. Respiratory viruses were identified as the primary causative agents of these symptoms.

¿ES NECESARIA LA PUNCIÓN LUMBAR EN EL LACTANTE FEBRIL CON FONTANELA ABOMBADA?

Resumen

Introducción y objetivos: La meningitis bacteriana es una causa de fiebre y fontanela abombada con una morbimortalidad elevada, por lo que las guías clínicas apoyan la realización de una punción lumbar a los pacientes con esta clínica. El objetivo de este estudio es determinar si podría no ser obligatoria su realización en algunos pacientes seleccionados.

Material y métodos: Tras realizar una revisión retrospectiva de los pacientes valorados en nuestro centro por fontanela abombada y síndrome febril, llevamos a cabo una revisión bibliográfica en Pubmed. Se usó como criterio de búsqueda (“bulging fonta-

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nelle" OR "bulging fontanel") AND ("fever" OR "febrile") y se recogieron los principales resultados de los estudios seleccionados.

Resultados: Presentamos una serie de casos con las características clínicas, pruebas complementarias y evolución de cinco lactantes con síndrome febril y fontanela abombada. En nuestra serie los virus respiratorios fueron la etiología principal. En la revisión bibliográfica se incluyeron un total de 9 artículos. Dos concluían que la fontanela abombada justificaba la realización de punción lumbar, sin embargo, eran estudios realizados en zonas con morbi mortalidad por meningitis bacteriana elevada. El resto concluían que no existe ningún signo patognomónico y que es necesario considerar una constelación de signos, entre los que destaca el aspecto del niño para decidir el manejo de estos pacientes.

Conclusiones: La fontanela abombada aislada en contexto febril en lactante con buen estado general parece tener escasa sensibilidad, especificidad y valor predictivo positivo para la detección de meningitis en nuestro medio, siendo los virus respiratorios los principales causantes de este cuadro.

INTRODUCTION AND OBJECTIVES

A bulging fontanelle is indicative of increased intracranial pressure in children whose cranial sutures have not fused. It can be a benign and self-limited finding; however, it is important to differentiate between entities that may require acute therapeutic management, such as hydrocephalus, tumors and trauma⁽¹⁾. Additionally, viral infections can cause bulging of the fontanelle⁽²⁾. Nevertheless, bacterial meningitis is a severe disease, and clinical guidelines recommend performing a lumbar puncture (LP) in patients with febrile syndrome and bulging fontanelle^(3,4), without specifying which patients may not need the procedure.

Taking into account the incidence of bacterial meningitis in Spain, which is below 10 cases per 100,000 inhabitants, and in addition to presenting our series of patients, the aim of this study was to review the existing literature on the need to perform lumbar puncture in this group of patients.

METHODS

We first conducted a retrospective review of the experience in our emergency department regarding the management of febrile infants with bulging fontanelle between January 2020 and December 2022. Clinical characteristics, complementary tests and outcome were collected through the electronic medical records. Verbal informed consent was obtained from parents/legal guardians via telephone call to conduct the review in an anonymized manner. Infants with suspected meningitis but without bulging fontanelle, as well as neonates under 28 days old, were excluded from the review.

The second part of the study consisted of a systematic review, conducted in accordance with the PRISMA 2020 guidelines. We reviewed the PubMed database from March 6 to March 10, 2023, using the following search terms: ("bulging fontanelle" OR "bulging fontanel") AND ("fever" OR "febrile"). The review was carried out by a pediatric resident and a pediatric attending physician. The process began with screening titles and abstracts, followed by a full-text review of the selected manuscripts for final inclusion in the review.

Articles evaluating the role of fontanelle bulging in the diagnosis of meningitis through case-control comparisons were included. Exclusion criteria were studies that included only children under 2 months of age, isolated case reports, and publications not in English or Spanish. In addition, articles with cohorts consisting only of bacterial meningitis cases without controls were excluded, as they analyzed only the characteristics of patients diagnosed with meningitis at the onset, rather than providing the comparative analysis that was the objective of our study.

The following information was collected from each study: the first author's surname, year of publication, country where the study was conducted, study design, scale of the study, number of patients, patient age, reason for performing lumbar puncture, lumbar puncture results, and study conclusions.

RESULTS

We present a series of five patients evaluated in the emergency department for fever and bulging fontanelle. Three were referred from primary care centers: two for fever and bulging fontanelle identified on physical examination, and one for bulging fontanelle and increased head circumference (from the 90th to the 97th percentile) without associated fever. Two patients came directly to our emergency department with febrile symptoms. LP was performed in four cases, all of which showed normal biochemistry. None of the patients had elevated acute phase reactants, except for one with a procalcitonin level of 1 ng/ml. All infants were admitted to the pediatric ward, with resolution of the bulging fontanelle within 24–48 hours. LP was not performed in one patient due to the presence of only low-grade fever in the emergency department, having been afebrile at home. Additionally, this patient showed oropharyngeal hyperemia on examination, and the epidemiological environment was positive. Nasopharyngeal swab samples confirmed the presence of respiratory viruses in all cases via reverse transcriptase polymerase chain reaction (RT-PCR). Two tested positive for SARS-CoV-2, two for influenza A, and one for influenza B, with all other microbiological results negative (Table 1).

TABLE 1. Patient characteristics.

Patient	Reason for consultation	Physical examination	Complementary studies ^{a,b}	Treatment and outcome
♀ 5 months	24-hour history of fever 38.5°C Bulging fontanelle, hypoactive	Altered appearance, hypoactive, Bulging fontanelle. Remaining examination normal	CRP 8, PCT 0.23 Hemograma normal Normal CSF study Influenza B+	Oral oseltamivir. Bulging of the fontanelle resolved 24 h
♂ 6 months Premature infant 25+6 weeks of gestation, bronchopulmonary dysplasia	10-hour history of fever 38.7°C, mucosity, irritability	Stable PAT, good general condition. Consolable irritability. Bulging fontanelle. Hyperemic oropharynx, mucus in the cavum. Remaining examination normal	CRP 15, PCT 0.27 CBC normal Normal CSF study COVID +	Admitted for observation. Bulging of the fontanelle resolved 24 h
♂ 6 months	24-hour history of fever 38.5°C. Mucosity, bulging fontanelle	Stable PAT, good general condition. Bulging fontanelle. Hyperemic oropharynx. Remaining examination normal	CRP 8. CBC: Leukocytes 2.07×10^9 (ANC 170), remaining study normal. Influenza A+. Sediment, bacterial blood and urine culture and CRP negative. Normal CSF study	Piperacillin-tazobactam Bulging of the fontanelle resolved 48 h. Progression to severe neutropenia (ANC 10), positive autoimmune neutropenia study
♀ 5 months	24-hour history of fever 40.7°C. Cough, mucosity	Stable PAT, good general condition. Bulging fontanelle. Hyperemic oropharynx. Remaining examination normal	CRP 12, PCT 1. Normal CBC. Influenza A+. Chest X-ray normal. Bacterial blood culture and CRP negative. Sediment negative. Normal CSF study	Admitted for observation. Bulging of the fontanelle resolved 48 h
♀ 7 months	Bulging fontanelle. Mucosity, cough, afebrile	Stable PAT, good general condition. Low-grade fever 37.3°C. Bulging fontanelle. Head circumference p97 (previously p90) Hyperemic oropharynx. Remaining examination normal	COVID +. Normal Transfontanelar ultrasound. LP not performed	Discharge to home. Brain MRI was requested but not performed because the fontanel and head circumference normalized

^aCRP expressed in mg/L; PCT expressed in ng/ml. ^bThe CSF study included biochemistry, cellularity, multiplex PCR, and culture.

During this period, three infants between 1 and 12 months of age were seen at our center for bacterial meningitis, none of whom had bulging fontanelle, and therefore, they were not included in this series. All had elevated acute phase reactants and were ill appearing.

Our literature search initially yielded 61 articles. After reviewing the titles, 43 were discarded, and 9 more were excluded after reviewing the abstracts (Figure 1). Finally, nine articles were included in the review (Table 2).

Only two authors, Lehman et al.⁽⁵⁾ and Berkley et al.⁽⁶⁾, concluded that a bulging fontanelle in a febrile child warrants a lumbar puncture, with Lehman et al.⁽⁵⁾ suggesting it as an independent factor for diagnosing meningitis. The remaining studies found no single pathognomonic sign for meningitis, emphasizing the need to consider a constellation of clinical signs, particularly the overall appearance of the child⁽⁷⁻¹²⁾.

Only two of the studies were published in the last decade (Takagi et al.⁽⁷⁾; Shahada et al.⁽¹³⁾). The first study retrospectively analyzed 764 patients who had undergone LP, 304 of whom presented with fever and bulging fontanelle. Ten cases of bacterial meningitis with positive cultures for *S. pneumo-*

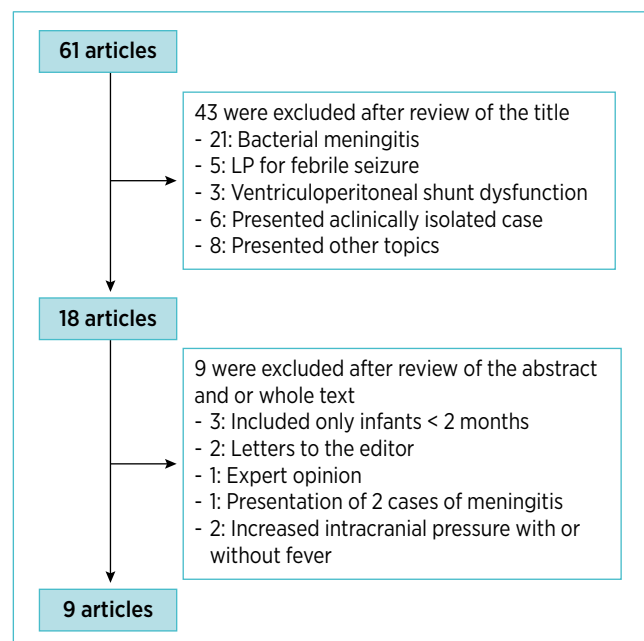


FIGURE 1. Flowchart of the study selection process.

TABLE 2. Summary of the included articles presented in chronological order

Article	Inclusion criteria and N	Results / conclusions
Clinical indicators for lumbar puncture Rosenberg NM et al. (1988, USA) <i>Prospective study</i>	< 24 months of life LP performed due to suspected meningitis N= 381 (151 > 3 months)	<ul style="list-style-type: none"> • Patients categorized according to low or high risk of meningitis • 14 cases (10 > 3 months): 13 categorized as high risk. The 14th had previously received antibiotics. • Bulging fontanelle does not always imply meningitis. 14 of 23 LP normal • A constellation of signs should be considered
Diseases that mimic meningitis. Analysis of 650 lumbar punctures Levy M et al. (1990, Israel) <i>Retrospective study</i>	LP performed due to suspected meningitis N= 650 (233 of 2-24 months)	<ul style="list-style-type: none"> • 28 cases between 2 and 24 months (12%) • Bulging fontanelle in 20% of meningitis cases, and 13% of infants with normal CSF • The bulging fontanelle would be a nonspecific sign
Aetiology and clinical signs of bacterial meningitis in children admitted to Goroka Base Hospital, Papua New Guinea, 1989-1992 Lehmann D et al. (1999, Papua Guinea) <i>Retrospective study</i>	1-59 months LP performed due to suspected meningitis N= 697	<ul style="list-style-type: none"> • Bacterial meningitis was confirmed in 30% of cases • Bulging fontanelle as an independent factor for diagnosis
Indicators of acute bacterial meningitis in children at a rural Kenyan district hospital Berkley JA et al. (2004, distrito rural Kenia) <i>Retrospective study</i>	> 60 days of life LP performed due to suspected meningitis Endemic area Malaria N= 999	<ul style="list-style-type: none"> • 91 cases of meningitis, 32% deaths • Bulging fontanelle in 30 patients, 16 had meningitis • LP should be indicated in all cases of bulging fontanelle
Transient bulging fontanelle after vaccination: case report and review of the vaccine adverse event reporting system Freedman SB et al. (2005, Toronto) <i>Retrospective study</i>	Infants with bulging fontanelle and fever after vaccination (2-6 months of life) N= 18	<ul style="list-style-type: none"> • 18 vaccination for DTP or DTaP and other vaccines • Fontanelle bulging 4 hours to 5 days after vaccination • 83% presented with fever • CSF study was normal in all • Conservative management of infants with bulging fontanelle should be considered, even after vaccination
Bulging fontanelle in febrile infants: is lumbar puncture mandatory? Shacham S et al. (2009, Israel) <i>Retrospective study</i>	3-18 months Fever and bulging fontanelle N= 153	<ul style="list-style-type: none"> • 1 case of bacterial meningitis • No cases in infants with good or excellent appearance
Clinical features suggestive of meningitis in children: a systematic review of prospective data Curtis S et al. (2010) <i>Meta-analysis</i>	Prospective studies analyzing clinical parameters of meningitis N= 10 studies	<ul style="list-style-type: none"> • No single criterion is diagnostic on its own • A bulging fontanelle increases the risk by 3.5 times, while its absence lowers the risk slightly
Bulging fontanelle in febrile infants as a predictor of bacterial meningitis Takagi D et al. (2021, Israel) <i>Retrospective study</i>	2-18 months LP performed due to suspected meningitis N= 764	<ul style="list-style-type: none"> • 304 cases of fever and bulging fontanelle • 10 cases of meningitis, all ill-appearing or with seizure • 1 case of meningitis with bulging fontanelle. Also ill-appearing, vomiting and lethargy • Isolated bulging fontanelle has low specificity, sensitivity, and positive predictive value
Outcomes of children presenting to the emergency department with fever and bulging fontanelle Shahada J et al. (2022, Israel) <i>Retrospective study</i>	3-13 meses Pacientes con fiebre y fontanela abombada N= 40	<ul style="list-style-type: none"> • LP performed only in 13 patients • 2 positive cultures • LP would not be essential

nae were diagnosed. Only one patient had bulging of the fontanelle, in addition to an ill appearance, vomiting, and lethargy, while meningitis was not diagnosed in any infant with a good appearance. The authors concluded that bulging fontanel would have low sensitivity, specificity and positive predictive value for the detection of meningitis. They highlighted respiratory viruses as the main etiology in their sample, although they did not specify which viruses were most commonly identified. In 2022, Shahada et al.⁽¹³⁾ presented

their center's experience, where lumbar puncture was not systematically performed. In a sample of 40 patients with fever and bulging fontanelle, after assessing the infant's general condition, vaccination status, and history, they performed 13 LPs and obtained 2 positive cultures. Based on these findings, they concluded that conservative management could be appropriate for infants with a good appearance and no relevant history, while LP should be indicated for those who did not meet these criteria.

The review by Freedman et al.⁽¹²⁾ highlights the association of bulging fontanel and febrile syndrome in infants after vaccination. However, the authors warn that this adverse effect to vaccination may have been reported after the short median symptom presentation time of 18 hours and that caution should be exercised with this association. In some countries, vitamin A is administered to infants in the first months of life and hypervitaminosis A may cause benign intracranial hypertension in infants with bulging fontanelle⁽¹⁴⁾. Nevertheless, the study emphasizes the importance of a comprehensive assessment of signs and symptoms and supports the option of conservative management for infants with bulging fontanelle, even after vaccination.

DISCUSSION AND CONCLUSIONS

Meningitis is a relatively rare disease in our setting due to vaccination programs; however, it remains a potentially serious condition that always alarms pediatricians when encountering a febrile infant with a bulging fontanelle. Although LP is a commonly used procedure among pediatricians, it is without contraindications and risks. In addition, performing an LP sometimes requires neuroimaging tests or sedation.

After reviewing a series of five infants in our center with bulging fontanelle and fever, but with excellent general condition, without elevation of laboratory acute phase reactants and with a normal CSF study, we studied the need to perform a LP in all cases to rule out meningitis, which led us to review the literature.

The existing literature on this subject is very limited, possibly due to the generally appropriate management of these patients, where LP is performed to rule out meningitis, and the lack of clinical trials involving pediatric patients.

Based on our review, the presence of a bulging fontanelle in a febrile infant with a good overall appearance may have low sensitivity, specificity, and positive predictive value for detecting meningitis in our setting, where the incidence, morbidity, and mortality of meningitis are low, with respiratory viruses being the primary causes of the condition. Additionally, recent vaccination history may also be an important factor to consider in the patient's clinical history.

It should be noted that the articles that strongly support the need for LP in all patients with febrile syndrome and bulging fontanelle were carried out in areas with high morbidity and mortality due to bacterial meningitis^(5,6).

The main limitations of our study are those inherent to literature reviews. Additionally, due to the limited existing literature on the subject, there is significant variability in terms of publication year and sample origin, affecting the reported incidence of meningitis. This variability is important when evaluating the need to perform LP in febrile infants with bulging fontanelle. Many of the studies were conducted in low- and middle-income countries, where there is a need to establish clinical guidelines for meningitis screening given the lower availability of medical resources.

The overall appearance of the child, the regional incidence of bacterial meningitis, the vaccination schedule, and the clinical-laboratory evaluation of the infant should be emphasized as key factors in assessing the likelihood of

a potentially serious infectious condition. These factors are crucial in determining whether invasive and potentially risky complementary tests are necessary for this population.

Our case series is too small to recommend modifications to the standard management of febrile infants with bulging fontanelle. The usual and appropriate practice in these cases is to perform an LP to rule out meningitis and obtain CSF for analysis. In certain specific situations—such as in countries with a low prevalence of central nervous system infections, under the care of an experienced pediatrician, with close clinical observation, and the possibility of performing imaging studies or initiating specific treatments if the clinical situation changes—the option of not performing an LP may be considered.

New prospective studies are needed to develop a predictive model or algorithm for the identification of meningitis and to allow certain children to be managed conservatively with close clinical observation, thereby avoiding the invasiveness of neuroimaging and LP.

REFERENCES

- Mercier JC. Signes évocateurs de méningite chez le nourrisson. *Médecine Mal Infect.* 2009; 39(7-8): 452-61. Available at: <https://linkinghub.elsevier.com/retrieve/pii/S0399077X09000894>.
- Tamer SK, Tamer U, Waley P. Infantile pseudotumor cerebri related to viral illness. *Indian J Pediatr.* 1996; 63(5): 645-9. Available at: <https://link.springer.com/10.1007/BF02730810>.
- Kneen R, Solomon T, Appleton R. The role of lumbar puncture in children with suspected central nervous system infection. *BMC Pediatr.* 2002; 2(1): 8. Available at: <http://bmcpediatr.biomedcentral.com/articles/10.1186/1471-2431-2-8>.
- Tunkel AR, Hartman BJ, Kaplan SL, Kaufman BA, Roos KL, Scheld WM, et al. Practice Guidelines for the Management of Bacterial Meningitis. *Clin Infect Dis.* 2004; 39(9): 1267-84. Available at: <https://academic.oup.com/cid/article/39/9/1267/402080>.
- Lehmann D, Yeka W, Rongap T, Javati A, Saleu G, Clegg A, et al. Aetiology and clinical signs of bacterial meningitis in children admitted to Goroka Base Hospital, Papua New Guinea, 1989-1992. *Ann Trop Paediatr.* 1999; 19(1): 21-32. Disponible en: <https://www.tandfonline.com/doi/full/10.1080/02724939992608>.
- Berkley JA, Versteeg AC, Mwangi I, Lowe BS, Newton CRJC. Indicators of Acute Bacterial Meningitis in Children at a Rural Kenyan District Hospital. *Pediatrics.* 2004; 114(6): e713-9. Available at: <https://publications.aap.org/pediatrics/article/114/6/e713/67876/Indicators-of-Acute-Bacterial-Meningitis-in>
- Takagi D, Oren-Ziv A, Shles A, Schujovitzky D, Yechiam H, Rosenbloom E. Bulging fontanelle in febrile infants as a predictor of bacterial meningitis. *Eur J Pediatr.* 2021; 180(4): 1243-8. Available at: <http://link.springer.com/10.1007/s00431-020-03865-4>.
- Shacham S, Kozer E, Bahat H, Mordish Y, Goldman M. Bulging fontanelle in febrile infants: is lumbar puncture mandatory? *Arch Dis Child.* 2009; 94(9): 690-2. Available at: <https://adc.bmj.com/lookup/doi/10.1136/adc.2009.158956>.
- Curtis S, Stobart K, Vandermeer B, Simel DL, Klassen T. Clinical features suggestive of meningitis in children: A systematic review of prospective data. *Pediatrics.* 2010; 126(5): 952-60. Available at: <https://publications.aap.org/pediatrics/article/126/5/952/65336/Clinical-Features-Suggestive-of-Meningitis-in>
- Rosenberg NM, Bobowski T. Clinical indicators for lumbar puncture: *Pediatr Emerg Care.* 1988; 4(1): 5-8. Available at: <http://journals.lww.com/00006565-198803000-00002>.

11. Levy M, Wong E, Fried D. Diseases that mimic meningitis: Analysis of 650 lumbar punctures. *Clin Pediatr (Phila)*. 1990; 29(5): 254–61. Available at: <http://journals.sagepub.com/doi/10.1177/000992289002900501>.
12. Freedman SB, Reed J, Burwen DR, Wise RP, Weiss A, Ball R. Transient bulging fontanelle after vaccination: case report and review of the vaccine adverse event reporting system. *J Pediatr*. 2005; 147(5): 640–4. Available at: [https://www.jpeds.com/article/S0022-3476\(05\)00518-4/fulltext](https://www.jpeds.com/article/S0022-3476(05)00518-4/fulltext)
13. Shahada J, Tavor O, Segev O, Rimon A, Scolnik D, Glatstein M. Outcomes of children presenting to the emergency department with fever and bulging fontanelle. *Am J Emerg Med*. 2022; 57: 153–5. doi: 10.1016/j.ajem.2022.04.011.
14. Imdad A, Ahmed Z, Bhutta ZA. Vitamin A supplementation for the prevention of morbidity and mortality in infants one to six months of age. *Cochrane Database Syst Rev*. 2016; 9(9): CD007480. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6457829/>