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Correlation between Neurologic Examination
and Neuroimaging**

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Emergent Headaches during Pregnancy: Correlation between Neurologic Examination and Neuroimaging

BACKGROUND AND PURPOSE: Emergent evaluation of the pregnant headache patient requires rational selection of acute neuroimaging studies, yet guidelines do not exist. We investigated the demographic and clinical features that are predictive of intracranial pathologic lesions on neuroimaging studies in pregnant women with emergent headaches.

MATERIALS AND METHODS: We conducted a retrospective review of demographic factors, clinical features, and radiologic findings in a consecutive case series of 63 pregnant women emergently evaluated with a chief complaint of headache, including those with previous headache histories. Clinical data were abstracted from emergency department records, hospital course, and discharge summaries. Multivariate logistic regression analysis examined predictors of intracranial pathologic lesions on emergent neuroimaging studies.

RESULTS: Multiparous African American women constituted 63% of the case subjects. Headaches were frequently accompanied by photophobia (59%), nausea (52%), vomiting (37%), and occasionally with fever (11%), meningismus (9%), or seizures (7%). A total of 43% of case subjects had abnormal neurologic examination findings. Emergent neuroimaging, including noncontrast head CT and MR imaging, revealed an underlying headache etiology in 27%, including cerebral venous thrombosis, reversible posterior leukoencephalopathy, pseudotumor, and intracranial hemorrhage. The odds of having intracranial pathologic lesions on neuroimaging were 2.7 times higher in patients with abnormal results on neurologic examination ($P = .085$).

CONCLUSIONS: Emergent neuroimaging studies may reveal an underlying headache etiology in 27% of pregnant women. Further research with a larger sample size is needed to determine what clinical factors are predictive of a pathologic condition on neuroimaging studies.

Headache is a common neurologic complaint among women of childbearing age.¹ The prevalence of headaches during pregnancy has been reported to be as high as 35%.² Although most headaches are unrelated to an intracranial pathologic lesion, some headaches may herald ominous diagnoses, including eclampsia, stroke, tumor, subarachnoid hemorrhage, or cerebral venous thrombosis. Emergent evaluation of headache in the pregnant patient requires rational selection of acute neuroimaging studies, yet guidelines do not exist. Often, the decision to investigate a headache in a pregnant patient through neuroimaging is based on the presence or absence of focal neurologic findings; however, there are no data to support this practice. We investigated the demographic factors, clinical presentations, and examination findings of pregnant women with headaches presenting to an emergency department in an academic center. Our hypothesis was that abnormal findings on neurologic examination would be predictive of an intracranial pathologic condition on acute neuroimaging studies.

Materials and Methods

A retrospective review of demographic factors, clinical features, and radiologic findings was conducted in a consecutive case series of 63 pregnant women (median age, 25 years; range, 15–41 years) evaluated for a chief complaint of headache at the emergency department of an urban, academic medical center. Clinical data were abstracted from emergency department medical records, hospital course, and discharge summaries.

Clinical variables included prior pregnancies; prior headache history; other medical conditions, including hypertension, diabetes, stroke, seizure disorder, or autoimmune disease; history of miscarriage; hypercoagulable states; smoking; alcohol and intravenous drug use history; family history of headaches; presenting features such as hours of headache, gestational age, seizure, neck pain, fever, nausea, or vomiting; headache features including quality (dull versus sharp), radiation, and changes with position; responsiveness to medications; examination findings including phonophobia, photophobia, visual symptoms, or meningismus; and normal or abnormal neurologic examination findings including mental status, cranial nerves, motor, sensory, gait, coordination, and/or reflexes. Radiologic variables included the use of various imaging modalities (CT, MR imaging, MR angiography [MRA], or MR venography [MRV]), time delay to imaging, and neuroimaging findings; classification of abnormal neuroimaging findings into incidental or pathologic groups was based on diagnosis given by the primary care providing team on patient discharge.

An odds ratio was generated by using SAS software (SAS Institute, Cary, NC) to examine the likelihood of having an intracranial pathologic condition in patients with focal neurologic examination findings (specifically, changes in mental status, cranial nerves, motor,

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Table 1: Breakdown of radiologic studies	
Radiologic Studies	N (%)
CT	54 (86)
MR imaging	38 (60)
MRA	2 (3)
MR imaging/MRV	25 (40)
CT only	25 (40)
MR imaging only	4 (6)
MR imaging and MRV only	5 (8)
CT and MR imaging	29 (46)

Note:—MRA indicates MR angiography; MRV, MR venography.

Table 2: Abnormal results on radiologic studies	
Variable	N (%)
Normal	31 (49)
Incidental	15 (24)
Pathologic condition	17 (26.9)
Cerebral venous thrombosis	4 (6)
Reversible posterior leukoencephalopathy syndrome/eclampsia	4 (6)
Pseudotumor	2 (3)
Intracranial hemorrhage (posterior pituitary bleed or ruptured aneurysm)	2 (3)
Sinusitis	5 (8)

sensory, gait, coordination, and/or reflexes). Multivariate logistic regression analysis examined several factors, including demographic information, clinical variables, presenting features, headache features, and examination findings as potential predictors of pathologic condition on emergent neuroimaging studies. Institutional review board approval was obtained before initiating this study.

Results

The characteristics of our patient population are summarized below: the mean age was 25.9 years (SD = 6.3 years), the mean number of previous pregnancies was 2.2 (SD = 1.9), and the mean gestational age was 24 weeks (SD = 9.6 weeks). Multiparous, African American women constituted most of the case subjects (63%), presenting with a severe headache at various time points throughout pregnancy. Headaches generally persisted for several hours and were described frequently as dull or throbbing (77%), bilateral (65%), and predominantly frontal (64%). Headaches were frequently accompanied by photophobia (59%), nausea (52%), vomiting (37%), phonophobia (23%), and occasionally with fever (11%), meningismus (9%), or seizures (7%).

Emergent neuroimaging included noncontrast head CT, MR imaging, MRV, and combinations of 2 or more of the above modalities. The frequencies of neuroimaging studies ordered are presented in Table 1. Emergent neuroimaging studies revealed an underlying headache cause in 27%, though sinusitis accounted for 8% of those cases. Intracranial pathologic conditions included cerebral venous thrombosis, reversible posterior leukoencephalopathy/eclampsia, pseudotumor, and intracranial hemorrhage. The frequencies of these findings are presented in Table 2.

A formal neurology consultation was obtained in 67% of case subjects; the others had a neurologic examination documented by the emergency department physician. There were abnormal neurologic examination findings in 43% of case subjects. The classification of findings as incidental versus

Table 3: Abnormal neurologic examination findings among pregnant patients with and without pathologic neuroimaging findings		
Variable	Pathologic Scan	Normal Scan
Abnormal neurologic examination findings	10	16
Normal neurologic examination findings	7	30
Total	17	46

pathologic was based on the diagnosis given by the primary care providing team on patient discharge; the most frequent incidental findings included prominent pituitary, artifactually attenuated-appearing tentorium, and nonspecific punctate focus of hyperintensity in white matter. Some incidental findings had been seen on previous scans before the current evaluation and included hypoplastic sinuses, congenital cystic structures, and one case of a closed-lip schizencephaly.

Twenty-six patients had focal findings on the neurologic examination; 10 of those patients had pathologic neuroimaging findings. Conversely, of 17 patients with pathologic neuroimaging findings, 7 had normal results on neurologic examination. It is noteworthy that 3 of the 4 patients who were diagnosed with reversible posterior leukoencephalopathy syndrome presented with headache, altered mental status, and seizures; only 1 had nonfocal results on neurologic examination. The abnormal neurologic examination findings in the 10 patients with pathologic neuroimaging findings included combinations of mental status abnormalities ($n = 6$), sensory abnormalities ($n = 4$), seizures ($n = 3$), cranial nerve abnormalities ($n = 3$), and pathologic reflexes ($n = 3$).

Table 3 shows the 2-by-2 table of the number of patients with pathologic conditions on neuroimaging who also had abnormal findings on neurologic examination. The odds of having an abnormal neuroimaging study were 2.7 times higher in those with abnormal results on neurologic examination compared with those with normal results; however, the 95% confidence interval ranged from 0.86 to 8.4 and was therefore not significant ($\chi^2 = 2.96$; $P = .085$). Multivariate logistic regression analysis was conducted on different presumptive predictors of intracranial pathologic conditions, including demographic factors, presentation symptoms, headache descriptions (including new-onset headaches), and findings on examination. However, there were no demographic or clinical variables that were predictive of intracranial pathologic condition on emergent neuroimaging studies. Two factors approached significance in predicting intracranial pathologic condition: mental status ($P = .184$) and increased hours of headache duration ($P = .07$).

Discussion

The evaluation of a pregnant patient with an acute headache in the emergency department requires careful consideration. Several reviews have characterized the various types of headaches and their frequencies in the pregnant patient.^{3,4} The International Headache Society (IHS) classifies headaches in pregnancy as primary or secondary and further subdivides them in to common and uncommon etiologies.⁵ The common causes of primary headaches in pregnancy include migraine and tension headache, and the uncommon causes include cluster and unspecified headaches. The common causes of sec-

ondary headaches include head trauma, vascular disorders, and intracranial pathologic condition, and uncommon conditions include substance abuse, systemic infections, metabolic disorders, cranial-structural disorder, and neuralgia. Although most patients in our sample fit the definition for primary headache, with migraines and tension headaches the most common, there were often missing data encountered in the descriptions of the headaches in the emergency department records, which prevented us from further classifying them according to IHS guidelines.

A few studies have developed algorithms for evaluating the pregnant patient who presents with a headache.^{5,6} However, these algorithms have not been validated, especially in an emergent setting. Ordering neuroimaging studies on the pregnant patient often causes unnecessary concern in those unfamiliar with the actual risks of the technique. In our study, the diagnosis was established on CT scan alone in a subset of case subjects. The amount of fetal radiation exposure is less than 0.001 Gy from a normal 10-section head CT scan; radiation exposure below 0.05 Gy has not been associated with fetal abnormalities.⁶ The most common combination of studies in our study was CT and MR imaging (46%), followed by MR imaging/MRV (40%); the indication for the latter was to rule out venous sinus thrombosis. Most case subjects with “worst headache of life” had a CT scan followed by a lumbar puncture instead of another imaging technique, such as MRA.

This study is the first to look at whether abnormal findings on neurologic examination, among other factors, can help in predicting who will have intracranial pathologic conditions on neuroimaging. On the multivariate analysis, 2 factors approached significance in predicting intracranial pathologic condition: mental status ($P = .184$), and increased hours of headache duration ($P = .07$). The latter, however, could represent a selection bias: only those patients who have had a persistent headache for several hours may choose to go to an emergency department for evaluation. The odds of having an intracranial pathologic condition on neuroimaging were 2.7

times higher in those with abnormal neurologic examination findings compared with those with a normal findings. Although this did not reach statistical significance, given the magnitude of the odds ratio and the χ^2 statistic, it is certainly possible that a future study with a larger sample size may provide a more definitive result. However, in the absence of such a study, the results of this study should caution physicians from basing their decision to order neuroimaging studies on the neurologic examination alone.

Conclusions

Neuroimaging studies may reveal an underlying headache etiology in 27% of pregnant women who present with an emergent headache. The diagnosis may be established on CT alone in a subset of case subjects. The odds of having an intracranial pathologic condition on neuroimaging were 2.7 times higher in patients with abnormal results of neurologic examination; however, this did not reach statistical significance in our study. This should caution physicians from basing their decision to order neuroimaging studies on results of the neurologic examination alone.

Further research is needed to determine what clinical factors are critical in determining the decision to order neuroimaging studies during pregnancy. Despite the frequent occurrence of concerning symptoms and examination findings, no clinical features are predictive of pathologic lesion on acute neuroimaging studies.

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