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Should the Babinski sign be part of the routine neurologic examination?

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Abstract—*Background:* The Babinski sign is a well-known sign of upper motor neuron dysfunction that is widely considered an essential element of a complete neurologic examination. Little is known about reliability and validity of this sign. A less well-known sign of upper motor neuron dysfunction, decreased speed of foot tapping, also has not been carefully evaluated. Scientific evaluation of findings of the physical examination is crucial in directing busy clinicians. *Methods:* Ten physicians (five neurologists and five non-specialists) examined each foot of 10 subjects, 8 of whom had known unilateral upper motor neuron weakness, 1 had bilateral leg weakness secondary to ALS, and 1 had no known neurologic deficits. Our main outcome measures were inter-rater reliability (kappa values) and accuracy (agreement with known upper motor neuron weakness). *Results:* The reliability of the Babinski sign was fair (kappa 0.30) and was substantial for foot tapping (kappa 0.73). Agreement with known weakness was 56% for Babinski sign and 85% for foot tapping. Reliability and accuracy for both tests were similar for neurologists and non-specialists. *Conclusions:* The interobserver reliability and validity of the Babinski sign for identifying upper motor neuron weakness are limited. Slowness of foot tapping may be a more useful sign.

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Since its introduction to neurology in 1896 by Joseph Babinski,¹ the sign that bears his name has been considered an important method of demonstrating upper motor neuron dysfunction. Plantar stimulation, a noxious stroking of the lateral sole of the foot, produces downward deflection (or plantar flexion) of the great toe in adults with normal upper motor neuron function and upward deflection (or dorsiflexion) of the great toe and fanning of the other toes in the presence of an upper motor neuron lesion. Evaluation for this upward deflection of the great toe, i.e., the Babinski sign, is considered an essential element of the complete neurologic examination^{2–5} and is required for some levels of billing.⁶ In spite of its ubiquitous practice, little is known about the reliability and validity of this sign. Other signs of upper motor neuron weakness include spasticity, hyperreflexia, and slowness of voluntary movements out of proportion to weakness.^{7–11} Slowness of movements in the lower extremities can be evaluated by comparing the maximum speed of tapping the foot on the two sides, which correlates with upper motor neuron function.¹²

Most non-neurologists do not perform the full neu-

rologic examination because of time constraints. In this setting, it is important to understand the reliability and utility of the Babinski sign and other components of the neurologic examination to focus attention on the most useful components. We tested the reliability and accuracy of the Babinski sign and the evaluation of foot tapping by 10 physicians (five neurologists and five non-neurologists) examining 10 subjects.

Methods. *Study population.* We received approval for testing of human subjects from the University of California, San Francisco (UCSF) institutional review board and all subjects provided written informed consent. Ten subjects (ages 44 to 76) were recruited from UCSF outpatient and inpatient services. Recruitment occurred without knowledge of prior assessments for the Babinski sign or foot tapping. Eight subjects had mild weakness of one leg, by history and on examination by one of the study investigators, attributed to a brain lesion that had been identified by brain imaging within 1 year of the study and had no evidence of a lesion that could cause contralateral weakness. Five of these subjects had ischemic strokes, one had complications from seizure surgery, and two had deficits after resection of arteriovenous malformations. One subject had ALS with spasticity and weakness in both legs. One subject had a normal neurologic examination. Subjects denied any new neurologic events between the time of brain imaging and the day of the study.

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Study design. Five neurologists and five primary care providers (two from internal medicine, two from family practice, one from emergency medicine) served as examiners. Examining physicians received no information about the subjects of this study. For determination of the Babinski sign, each subject was lying on his or her back on an examination table and was screened from the physician's view by a vertical sheet with only one leg exposed. Each physician was instructed to elicit the plantar response (test for the Babinski sign) as he or she would in actual practice; repeated assessments were allowed. Subsequently, the subject's other foot was exposed and examined by each physician. To prevent information on previous responses from influencing assessment of the second foot, subjects were moved to different rooms between evaluations. To further decrease the possible influence of any previous assessment, physicians were informed that for any given patient, one side, both sides, or neither side may be abnormal. Physicians were not aware of the number of patients with upper motor neuron lesions and were not permitted to view others' assessments. Raters were asked to determine whether the Babinski sign was present and to rate their confidence in the finding (high, medium, or low).

After all assessments for the Babinski sign were completed, examining physicians were asked to evaluate each subject's fastest rate of tapping one foot quickly against the examiner's hand. Each foot tap was rated as slow or normal. Both feet were tested during the same encounter, so physicians could compare rates of tapping. Several of the non-neurologists had not seen this test performed previously; verbal instruction was provided to all the physicians as a group. Physicians were not allowed to assess any other part of the neurologic examination. Neither of the authors was an examining physician.

Data analysis. The kappa statistic, which reflects the proportion of agreement between examiners that is greater than that expected by chance, was used as a measure of interobserver reliability, with grading based on the original description of the measure (values <0.20, slight/poor agreement; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; and 0.81 to 1.00, almost perfect).¹³ To determine whether kappa values for the plantar response and for foot tapping were significantly different, we used a bootstrap method with 1,000 replicate datasets, each of the same size as the original dataset, and evaluated the distribution of differences in kappa statistics. Validity was measured as the proportion of tests agreeing with the side of known upper motor neuron weakness. Accuracy (or validity) was compared between the plantar response and foot tapping using Fisher exact test. The Wilcoxon rank sum test was used to compare ratings of confidence in the Babinski sign between assessments that were concordant and discordant with the side of known upper motor neuron weakness. The Stata Statistical package (version 8.0, College Station, TX) was used for all analyses. For the Babinski sign, since each foot was evaluated at a different time and in a different location without knowledge of the previous evaluation, we consider each of the evaluations independent.

Results. One examiner failed to examine one subject's foot during the testing of the Babinski sign, so 199 independent tests were performed. A different examiner failed to examine foot tapping of either foot of one subject during testing, so 198 observations of foot tap were performed. Interobserver reliability was fair for testing the Babinski sign (kappa = 0.30) and substantial for evaluation of rate of foot tapping (kappa = 0.73) (table). Interobserver reliability was similar among neurologists and non-neurologists ($p > 0.05$).

Results of testing for the Babinski sign and foot tapping were assessed for agreement with known upper motor neuron weakness (see table). The Babinski sign correlated with known weakness in 56% of evaluations, with individual physicians correctly identifying presence of weakness in 40% to 65% of evaluations. The Babinski sign was considered present in 35 of 100 evaluations of lower extremities with upper motor neuron weakness (sensitivity 35%) and in 23 of 99 without weakness (specificity 77%). Slow-

Table Interobserver reliability and validity of the Babinski sign and foot tapping

	Overall	Neurologists	Non-neurologists
Babinski testing			
No. of evaluations	199	99	100
Kappa	0.30	0.28	0.36
Validity, %	56	58	54
Sensitivity, %	35	36	34
Specificity, %	77	80	74
Foot tapping			
No. of evaluations	198	98	100
Kappa	0.73	0.73	0.72
Validity, %	85	82	88
Sensitivity, %	86	86	86
Specificity, %	84	78	90

ness of foot tapping correctly predicted upper motor neuron weakness in 85% of evaluations (range for physicians, 75 to 95%), which was greater than for Babinski testing ($p < 0.0001$). Foot tapping was judged slow in 86 of 99 evaluations of lower extremities with upper motor neuron weakness (sensitivity 86%) and in 16 of 99 without weakness (specificity 84%). The sensitivity of foot tapping was greater than for the Babinski sign ($p < 0.0001$) but specificity of the two signs was similar ($p = 0.28$). Differences in validity, sensitivity, and specificity of testing between neurologists and non-neurologists were not significant for either test. Physicians also rated their confidence in the results of Babinski testing. Level of confidence was not associated with whether results agreed with presence of upper motor neuron weakness ($p = 0.20$).

Discussion. We found that the Babinski sign was unreliable and a poor predictor of the presence of upper motor neuron weakness. Physicians often found it in unaffected limbs and failed to find it in affected limbs, and their confidence in the assessment did not predict accuracy. Testing for speed of foot tapping was much more reliable, sensitive, and specific. These findings are at odds with a current emphasis on testing for the Babinski sign as part of the routine neurologic examination; contrarily, foot tapping is not recommended as part of a standard neurologic examination.²⁻⁵

Should testing for the Babinski sign continue to be a part of the routine neurologic examination? Our study and several others suggests that the answer is no. Accordingly, changes in priorities listed in textbooks, Medicare billing requirements, Neurology board certification examinations, and medical school teaching may be required. We recognize that the widespread knowledge of the Babinski sign, its use as a teaching tool, and its strong historical association with neurology are likely to slow such a wide-sweeping change in practice parameters. Perhaps the most important, immediate consequence of the study is to help refocus busy practitioners. Our study

suggests that other parts of the neurologic examination, such as foot tapping, may provide more useful information than testing for the Babinski sign.

Our study is not the first to call into question the reliability and validity of the Babinski sign. The Babinski sign has undergone several challenges to its validity and interpretation,¹⁴⁻¹⁷ and has been defended by others.¹⁸⁻²¹ However, there are only three studies that have systematically studied the reliability of the Babinski sign: two reporting poor reliability and one from a single examiner reporting excellent reliability and validity. One study of 24 physicians examining 12 patients demonstrated poor interobserver reliability (kappa 0.17).²² Examiners were blinded to diagnosis and other parts of the neurologic examination but no comparison with side of known weakness was made. Another study of two unblinded physicians examining 41 men on a geriatric psychiatry ward also found poor interobserver reliability.²³ In addition, the authors raised concern about the specificity of the test since they found a positive Babinski sign in 21% of the responses, while they had expected none based on history and lack of other findings of upper motor neuron dysfunction. One study found almost perfect intraobserver reliability (kappa = 0.98), based on the observations of an unblinded single examiner and 100 consecutive patients with hemiparesis and 100 healthy controls.²⁴ Since testing for the Babinski sign was part of a neurologic examination in this study, it is possible that lack of blinding to other elements of history and examination influenced the assessments, a bias that has been demonstrated previously.²⁵ None of these studies has addressed validity and determined the sensitivity and specificity of the test using multiple examiners blinded to the diagnosis and other parts of the neurologic examination.

Although slowness of movements is a well-recognized upper motor neuron sign,^{2,3,5} reliability and validity have not been well studied for repetitive foot tapping. In children, test-retest correlation coefficients were 0.77 to 0.85;²⁶ similar studies have not been performed in adults and little is known about interobserver variation or correlation with known weakness. We are unaware of studies other than our own that have systematically analyzed reliability and validity of foot tapping.

Among both neurologists and non-neurologists, recognizing weakness and incoordination is an important part of the examination that directs further workup. Our results show that slowness of the speed of foot tapping is a sensitive and specific sign of weakness in patients with lesions of the CNS (i.e., loss or dysfunction of upper motor neurons). Since slowness of movements out of proportion to weakness is associated with loss of upper motor neurons,^{7,10,11} not loss of lower motor neurons (such as from injury to a peripheral nerve),^{8,9} we predict that this sign would be particularly sensitive as a marker of upper motor neuron weakness. However, speed of foot tapping may be affected by extrapyramidal dis-

orders or other processes such as joint disease affecting the lower leg or ankle, and its specificity is likely to depend on an accurate history and general physical examination. The sign could be further improved by noting the specific number of taps in a given time frame since this would allow comparison between patients and over time; however, this will require independent validation to determine its reliability. Our study does not address how well either the Babinski sign or foot tapping would distinguish between weakness secondary to loss of upper vs lower motor neurons since all of the patients in our study had known upper motor neuron lesions. The poor performance of the Babinski sign in predicting the side of known weakness would likely limit its utility for that purpose. Despite these reservations, the Babinski sign is likely to retain some utility, as part of an assortment of tests available to skilled practitioners. One obvious advantage of the Babinski sign over foot tapping is the ability to perform the test on uncooperative or comatose patients. In addition, the Babinski sign may, in some cases, alert the examiner to an upper motor neuron lesion in patients with predominantly lower motor neurons signs (e.g., subacute combined degeneration, Friedreich's ataxia).

It is surprising that there was no difference in values between neurologists and non-neurologists, despite the fact that the neurologists would be anticipated to be more familiar with evaluating both signs. On the other hand, neither foot tapping nor determination of Babinski sign is a particularly complicated procedure to perform or interpret; thus, any well-trained physician might be expected to gather similar information. The fact that these two groups performed nearly identically suggests that the poor performance of the Babinski sign is not related to physician skill or training, but rather to the sign itself. Similarly, the sign was inaccurate in the hands of all the physicians, so no practitioner used a specific technique that worked well.

Selection of subjects included in this study may have affected our results. However, we selected subjects with knowledge of the presence of upper motor neuron weakness but without knowing whether the Babinski sign or slowed foot tapping was present. We selected practicing neurologists and non-neurologist adult physicians from an academic medical center, and their selection could have impacted our results. Nonetheless, examination skills were not considered in selection and we expect the performance of other practicing neurologists and primary care physicians would be similar. In addition, we did not allow practitioners to compare plantar responses side to side, and this may have reduced its accuracy but should not have reduced its reliability.

Given the many pressures on physicians to shorten evaluation times, scientifically identifying the key, useful components of the examination is essential. Our results suggest that the Babinski sign should be de-emphasized both in teaching and documentation practices. If time is limited, primary care

physicians and neurologists should focus on other aspects of the neurologic examination, including speed of foot tapping.

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