



A New Method of Eliciting Pyramidal Tract Impairment in Adults

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Abstract

Background: To suggest a new way of eliciting pyramidal tract dysfunction in adults since the most widely utilized plantar reflex, which is the Babinski reflex, has limitations with different reliability and consistency among different examiners.

Materials and methods: 168 adult subjects were examined for the new sign in addition. It consists of just an observation of the patient's feet and toes in a conscious patient looking for the extension of the great toe along with fanning, spreading and plantar flexion of the small toes either at rest or when patient elevates one leg up at a time.

Results: We were able to observe the extension of the great toe along with fanning, spreading and plantar flexion of the small toes in patients with impairment of pyramidal tract. The specificity was 94% while the sensitivity was 96%.

Conclusion: Pyramidal tract lesion in adults can be elicited by this new test that observes the extension of the great toe along with fanning, spreading and plantar flexion of the small toes in patients. We suggest this sign as a complement to established signs like Babinski reflex.

Keywords

Babinski, extensor plantar response, pyramidal sign, Pasupuleti sign

BACKGROUND

Testing of reflexes is an essential component of neurological examination. The most widely utilized plantar reflex is elicited when the lateral aspect of the sole of the foot is stimulated along the path that runs from the heel along a curve to the toes or the pads of the metatarsus.¹

Joseph Babinski described this and the possible outcomes when this reflex was elicited include the flexor response observed in normal individuals with the toes curving down, inwards with foot eversion. This also exists as a primitive reflex among infants till roughly two years of age. Other outcomes include extensor response, which is

referred to as the Babinski sign, and it is characterized by hallux dorsiflexion, fanning out of the other toes. This is observed in adult individuals with pyramidal tract impairment. An indifferent response is when there is no observed response.²

Variants of the Babinski sign has been reported and they include Chaddock, Oppenheim, Gordon, Stumpell, Moniz, Gonda, Allen, Bings, Stransky, Chekov & Rossolimo, Mendel-Becheterev and Puusepp.³⁻¹⁰

Reliability and consistency of the Babinski reflex vary among different examiners. In order to compensate, most clinicians often utilize more than one reflex to evaluate the plantar response.²

Babinski reflex and most of the variants of Babinski re-

quires the clinician to elicit the reflex by actively touching the patient. Many physicians do not perform this sign accurately and patients may feel uncomfortable, withdrawing their feet thus compromising the results of the test. Skin conditions such as excessive callus, keratinization under the plantar aspect of the feet, ulcers of the feet and legs may limit the use of Babinski sign and other alternative signs.

The enumerated shortcoming of the Babinski reflex was what made us suggest a new way of eliciting pyramidal tract dysfunction among adults.

MATERIALS AND METHODS

Ethics approval for this study was obtained from the Institutional Review Board and informed consent was obtained from all subjects. The investigation conforms to the principles outlined in Declaration of Helsinki.

One hundred and sixty-eight adults that presented for neurological evaluations in the Consult service of a team led by the Principal investigator DV Pasupuleti, MD, FACP, FAANEM were recruited over a two-year period. DVP has been practicing neurology for more than 31 years in addition to being Professor in two Universities; being the former Director of Neurology at one of the three local University affiliated hospitals and a teaching neurologist. These cohort of patients were seen at these three university affiliated hospitals and also patients seen in his private practice.

Sixty-three patients had confirmed pyramidal tract dysfunction by CT, MRI of the brain with pathologies ranging from stroke, multiple sclerosis, small vessel disease (leukoaraiosis), subdural hematoma etc.

DVP conducted extensive neurological examination for signs of pyramidal tract dysfunction such as Babinski reflex, hemiparesis, facial paresis, lagging behind of the nasolabial fold with asymmetry of the smile, downward drift pronator drift or hyperactive reflexes with or without wrist, patellar or ankle clonus, and spasticity

These established signs of pyramidal tract dysfunction served as gold standard comparison for the new sign that we aimed to describe.



Figure 2. Extensor response.

Each patient was observed for the appearance of the pyramidal tract lesion by 1) Observe the feet and legs at rest in supine or sitting position. 2) Ask the patient to raise one leg up at a time and observe for the extension of the great toe along with fanning, spreading and plantar flexion of the small toes. 3) Repeat step 2 with the other leg and observe for the same findings (Fig. 1). 4) Then ask the patient to raise both legs at the same time without touching each other and observe for the extension of the great toe along with fanning, spreading and plantar flexion of the small toes (Fig. 2). Extension of the great toe along with fanning, spreading and plantar flexion was documented as evidence of pyramidal tract lesions together with pictorial and video recording of this (Figs 1, 2).

A group who was blinded to the subjects presenting pathology was given pictorial instructions on how to identify the newly described reflex. They were to interpret the reflex as flexor response observed in normal individuals with the toes curving down, inwards with foot eversion (Fig. 1-3). Other outcomes include extensor response, which is referred to as the Babinski sign, and it is characterized by hallux dorsiflexion, fanning out of the other toes (Figs 2-1, 3-2). An indifferent response is when there is no observed response.²

This group consisted of internal medicine residents, combined internal medicine and pediatrics residents, med-



Figure 1. Extensor response.



Figure 3. Flexor response/normal.

Table 1. Participant data and results

Patient	Age range in years	Number	Male	Female	Plantar response	Extensor response
UMN	20-93	63	22	41	2	61
Control	18-35	105	34	71	99	6
Total		168	56	112	101	67

UMN: upper motor neuron lesion

Table 2. Diagnoses of the study participants

Clinical diagnoses of patients with UMN lesion	Number of patients	Clinical diagnoses of control patients	Number of patients
Tuberous sclerosis	1	Transient ischemic attack	21
Extensive small vessel disease	27	Headache	27
CVA with infarct	15	Seizures	9
Spinal cord	2	Syncope/dizziness	5
Brain sarcoidosis	1	Alzheimer's dementia	4
Cervical spine sarcoidosis	1	Tremor	3
Multiple sclerosis	8	Trigeminal neuralgia	1
Subdural hematoma	3	Parkinson's disease	2
Brain metastasis	1	Chiari 1 malformation	2
Cervical stenosis with myelopathy	3	Double vision	1
Paraneoplastic syndrome	1	Miscellaneous	30
Total	63	Total	105

Miscellaneous includes attention deficit hyperactivity disorder, explosive personality disorder, hypertension, diabetes, weakness, and sleep apnea

UMN: upper motor neuron lesion. Patients had confirmed pyramidal tract dysfunction by neurological examination, CT, MRI of the brain while control patients were examined and did not have any confirmed pyramidal tract dysfunction by neurological examination, CT, or MRI of the brain.

ical students, nurse practitioners, physical therapists, nurses and student nurses.

RESULTS

We analyzed 168 survey responses from the group aforementioned above. Patient clinical data and their responses to the new sign are outlined in **Tables 1** and **2**.

Nineteen patients had bilateral evidence of pyramidal tract dysfunction, 19 had right-sided pyramidal tract dysfunction, 15 had left-sided pyramidal tract dysfunction while 10 patients were ticklish with up going toes observed without eliciting with Babinski etc.

The specificity (TN/TN+FP) was 94% while the sensitivity (TP/TP+FN) was 96% with most of them properly identifying the extension of the great toe along with fanning, spreading and plantar flexion as evidence of pyramidal tract

lesions in the patients who had other confirmatory signs of pyramidal tract lesions. The sign can easily be observed by any medical professional at different levels of their training as exemplified by the fact that similar results was observed amongst the different medical personnel including medical students and nursing professional.

DISCUSSION

This sign provides physicians with additional clinical observation they can immediately use to improve patients care in their practice. Eliciting reflexes is a crucial portion of most neurological examination.¹

Limitations of Babinski reflex such as conflicting reliability and consistency of among different examiners has led to description of variants of the Babinski reflex.²

Furthermore, Babinski results are sometimes hampered

due to the fact that some patients are ticklish, some physicians do not perform this sign accurately and presence of skin lesions. This limitation of the Babinski reflex was what made us suggest a new way of eliciting pyramidal tract dysfunction among adults.

The merits of this new way of eliciting pyramidal tract dysfunction among adults include the fact that it is easy to demonstrate because it is just an observation, no need to touch the patient's feet or legs thus preventing withdrawal of the examining foot in ticklish patients.

Both phases of extension of the great toe along with fanning, spreading and plantar flexion of the small toes can easily be observed.¹¹

The sign can easily be observed by any medical professional and there is no difficulty in the interpretation. The sign correlates well with all the pyramidal tract lesions.¹²

The mechanism of the plantar extensor response is the same as the other signs like Babinski and involves activation of the tibial nerve and contraction of the gastrocnemius.

Limitations of this new way of eliciting pyramidal tract dysfunction among adults in comatose patients, patients with dense hemiplegia and in paraplegic patients may not be able to elevate their feet thus direct observation may suffice. If the sign is not visible on direct observation, the examiner can elevate patient's feet in order to elicit the sign. Patients with abnormalities or lesions that have distorted their foot architecture such that they are fixed in perpetual extension of the great toe along with fanning, spreading and plantar flexion of the small toes may have a false positive sign.

CONCLUSION

We would like to propose this sign be referred to as 'Pasupuleti sign' and we believe that this sign would be an excellent complementary sign to the existing Babinski reflex. Also in situations where patient is ticklish, this sign may suffice.

Author Contributions

D Pasupuleti conceived the paper, oversaw manuscript collection, conducted data analysis, wrote the manuscript and approved final version. FC Osuagwu conducted manuscript collection, conducted data analysis, co-wrote the manuscript and co-approved final version. R Bradley participated in the study design, data analysis, and interpretation of data and revision of manuscript and approved final version. U Pasupuleti participated in the study design, data analysis, and interpretation of data and revision of manuscript and approved final version. The authors declare that they have no conflicts of interest.

REFERENCES

1. Boes CJ. The history of examination of reflexes. *J Neurol* 2014; 261(12): 2264-74.
2. Singerman J, Lee L. Consistency of the Babinski reflex and its variants. *Eur J Neurol* 2008; 15(9): 960-4.
3. Allen IM. Application of a stretch reflex for identification of lesions of upper motor neurons. *NZ Med J* 1945; 44: 227-33.
4. Babinski J. Sur le réflexe cutané plantaire dans certaines affections organiques du système nerveux central. *C R Soc Biol* 1896; 48: 207-8.
5. Chaddock CG. A preliminary consideration concerning a new diagnostic nervous sign. *Interstate Med J* 1911; 12: 742-6.
6. Gonda VE. A new tendon stretch reflex: its significance in lesions of the pyramidal tract. *Arch Neurol Psychiatry* 1942; 26: 531-8.
7. Gordon A. A new reflex: paradoxical flexor reflex and its diagnostic value. *Am Med* 1904; 8: 971.
8. Moniz E. Le signe de la flexion plantaire du gros orteil avec la jambe en flexion. *Revue Neurologique* 1916; 30: 173-6.
9. Oppenheim H. Aur Pathologie der Hautreflexe an der unteren Extremitäten. *Monatsschr Psychiatri Neurol* 1902; 12: 421-3.
10. Strümpell AV. Ueber das Verhalten der Haut- und Sehnenreflexe bei Nervenkranken. *Neur Cbl* 1899; 18: 617-9.
11. Van Gijn J. The Babinski sign and the pyramidal syndrome. *J Neurol Neurosurg Psychiatr* 1975; 38: 180-6.
12. Morrow JM, Reily MM. The Babinski sign. *Br J Hosp Med (Lond)* 2011; 72(10): M157-9.

Новый метод определения повреждений пирамидного тракта у пожилых пациентов

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Абстракт

Введение: Предложить новый способ установления дисфункции пирамидного тракта у пожилых пациентов, поскольку наиболее часто используемый подошвенный рефлекс, а именно рефлекс Бабинского, имеет ограничения относительно степени надёжности и согласованности в среде специалистов.

Материалы и методы: 168 пожилых пациентов были проверены на наличие нового признака. Он состоит только в том, чтобы наблюдать за ступнями и пальцами ног пациента в сознании и искать разгибание большого пальца ноги, а также разгибание, вытягивание и подошвенное сгибание маленьких пальцев или в состоянии покоя, или когда пациент поднимает каждую ногу отдельно.

Результаты: Мы смогли наблюдать разгибание большого пальца с растяжением, вытягиванием и подошвенным сгибанием маленьких пальцев у пациентов с повреждением пирамидного тракта. Специфичность составила 94%, а чувствительность - 96%.

Вывод: В этом новом исследовании было выявлено поражение пирамидного тракта, в котором наблюдалось разгибание большого пальца ноги, а также разгибание, вытягивание и подошвенное сгибание маленьких пальцев ног пациентов. Мы предлагаем использовать этот признак в качестве дополнения к уже установленным признакам, таким как рефлекс Бабинского.

Ключевые слова

пирамидный признак, признак Пасупулетти, Бабинский, разгибательный подошвенный рефлекс
