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Planter reflex: An important superficial reflex

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Abstract
The plantar reflex is a nociceptive segmental spinal reflex that occurs as a normal defensive response to any painful stimulus. It is a sensitive and reliable method for evaluating the integrity of the motor pathways to the lower limb. The Babinski reflex is characterized by the hyperextension of the big toe and the fanning out of the other toes when the foot is stroked upward from the heel. There are various methods to elicit the Babinski signs.

Keywords: plantar reflex, Babinski sign, lower limb, pyramidal tract

Introduction
The Plantar reflex is a polysynaptic superficial reflex, intended to withdraw the stimulated part, i.e., the foot from a potentially risky stimulus. It was first described by the neurologist Joseph Babinski in 1899 in his paper *reflexe cutane plantaire*. He mentioned in his paper that: "Stimulation of the sole on the healthy side of a patient with hemiplegia or lower limb monoplegia caused withdrawal of the lower limb with flexion of the toes at the metatarsal bones. In contrast the same stimulus applied to the sole on the affected side caused extension of the toes at the metatarso-phalengeal joints, even in patients who were unable to move their toes voluntarily". Since then, it has been incorporated into the standard neurological examination. The Babinski reflex is easy to elicit and does not require sophisticated equipment. It also, requires little active patient participation, so it can be performed in patients who are otherwise unable to cooperate with the neurological exam [1, 3]. The superficial reflexes are mainly controlled by centers in the spinal segment L4 to S2 cord segments.

Planter reflex arch
- The Reflex arc for the plantar reflex comprises of the afferent and efferent fibres in the tibial nerve and the L4-S2 cord segments.
- **Reflexogenic area:** Skin on the sole of the foot.
- **Afferent fibres:** Tibial nerve, branch of the sciatic nerve
- **Spinal Segment:** L4-S2 segments.
- **Efferent fibres:** Sciatic nerve which divides into two large branches just proximal to the knee.
- Fibers supplying the toe flexors travel in the tibial nerve
- Fibers supplying the toe extensors travel in the peroneal nerve to reach the foot.
- The stimulation of the lateral plantar aspect of the foot normally leads to plantar flexion of the toes (due to stimulation of the S1 myotome).
- The nociceptive input travels up the tibial and sciatic nerve to the S1 region of the spine and synapse with anterior horn cells. The motor response which leads to the plantar flexion is mediated through the S1 root and tibial nerve. So, the toes bend down and inward. The interneurons in the planter reflex arc connect with motor neurons at several segmental levels, leading to a coordinated motor response or movement of the foot and lower limb following cutaneous stimulation of the sole of the foot [2, 4].
- Injury of the tibial nerve would interrupt the afferent and efferent arcs of the normal plantar response, leaving the toe extensor muscles innervated.

Standard Method of elicitation of Planter Reflex
- Patient is made to lie down in supine position
- Knee slightly flexed and thigh externally rotated
- Fix the ankle joint
- Stroke the lateral aspect of the sole from heel towards the ball of the great toe.
- Stroke slowly, taking 5 or 6 seconds to complete the motion.

Stimulation
- To stimulate mainly the lateral plantar surface and the transverse arch in a single movement upto the middle metatarsophalangeal joint.
- It's important to start laterally because in some cases the response is abnormal laterally and then becomes normal as the midline is approached. The occurrence of the extensor response on any of these lines is abnormal, even if the response is flexor on another line of stroking.

Instrument used for elicitation of reflex
- Non-injuring blunt object like reflex hammer, key, etc.
- Use thumb nail in infant and young children.
- Strength of Stimulation: Strength of the stimulus depends upon the degree of the response. In patients with no response, progressively firmer stimulus may be required. In patients with strongly extensor response, only a touch of fingers may be enough [3, 5].

Normal Planter Reflex

- Also called as flexor plantar reflex.
- There is a plantar flexion of the foot and toes along with adduction of the toes
- May be accompanied by an associated flexion of the hip and knee on the stimulated side.

Babinski's sign / Babinski's Response

- In pyramidal tracts lesion, the characteristics response is dorsiflexion (extension) of the great toe along with fanning out and extension of the other toes. In addition, there is dorsiflexion at the ankle with flexion at the hip and knee joint. This response is known as positive

Babinski's sign.

- There is contraction of the tibialis anterior, hamstrings and tensor fascia lata, leading to the response. It is always a pathological occurrence.

Types of Babinski's Responses

a. Minimal Babinski sign: Contraction of hamstring muscles and tensor faciae latae.

b. True Babinski sign: Completely developed extensor plantar reflex with all components. True Babinski signs can be differentiated from the false by the contraction of hamstring muscles, and failure to inhibit the extensor response by pressure over the base of the great toe, in the former.

c. Exaggerated Babinski sign: It can be divided into two categories as 'flexor spasm' or 'extensor spasm', depending upon which group of muscles have increased tone i.e. whether flexors or extensors.

- Flexor spasms: Mainly seen in spinal cord disease, multiple sclerosis, neuron lesion at a supraspinal level, and subacute combined degeneration of the cord.
- Extensor spasms: Mainly occurs in corticospinal tract lesion when the posterior column function is normal.

d. Tonic Babinski reflex: Slow prolonged contraction of extensors of toe, which are often found in lesions of the frontal lobe and extrapyramidal involvement.

e. Crossed extensor response / Bilateral Babinski sign: Spinal cord and bilateral cerebral diseases can produce bilateral Babinski on unilateral stimulation

f. Spontaneous Babinski reflex: Passive extension of the knee or passive flexion of the hip and the knee may produce Babinski's in extensive corticospinal tract lesions (4-6).

Babinski's Mimickers

- **Pseudo Babinski sign:** Particularly seen in condition like hyperkinesis, choreoathetosis, hyperaethesia, extrapyramidal lesion, under effect of sedation, deep sleep and spinal shock. Response may be misinterpreted to be a 'True Babinski's sign',
- **Inversion of plantar reflex:** May be seen in conditions where the flexor tendons have been severed or the short flexors of the toe are paralyzed. In such cases, extensor response may be observed.
- **Withdrawal response:** voluntary

Age wise changes in the reflex

- **Neonates**: Babinski's extensor response
- **Infants**: Babinski's extensor response
- **Toddler**: Planter flexor response
- **Children / Adult**: Planter flexor response

Causes of an extensor plantar response

It is usually found in pyramidal tract lesions, Infant, deep sleep, coma, post-ictal stage of epilepsy, general anesthesia, hypoglycemia, electroconvulsive therapy or head trauma with concussion.

Other methods of elicitation of plantar reflex

1. Oppenheim sign (shin-toe reflex): Heavy pressure is applied by knuckles or the thumb and index finger on the shin of tibia from above downwards. The response occurs towards the end of stimulus.
2. Gordon sign (calf-toe sign): Pressure is applied on the calf muscles or tendo-archilles by squeezing/pinching to produce extensor plantar response.
3. Gonda sign / Allen sign (toe-pull reflex): Forceful downward stretching or snapping of distal phalanx of either of the second or fourth toe.
4. Chaddock sign: Skin around lateral malleolus is stroked in circular fashion.
5. Cornell sign: The dorsum of the foot is scratched along the inner side of extensor tendon of the great toe
6. Thockmorton sign: The dorsal aspect of the metatarsophalangeal joint of the great toe is percussed.
7. Stansky sign: The fourth toe is abducted maximally and then released suddenly.
8. Schaefer sign (Achilles- toe reflex): Deep pressure or squeezing over the tendo-achilles tendon produces extensor response.
9. Bing sign (pin-prick toe reflex): Dorsum of foot is pricked by a pin.
10. Moniz sign: Forceful passive plantar flexion of ankle.
11. Strumpell sign: Forceful pressure is applied over the anterior tibial region.

Role of Corticospinal tract (CST) in Planter Reflex

- The cortex can influence and modify the spinal reflex via the superficial influences.
- The Babinski reflex tests the integrity of the cortical spinal tract
- The impulse from the lumbosacral cord segments ascend up through the spinal cord and brainstem to the motor cortex of the brain. Then the efferent impulses from motor and premotor areas, descend down in the corticospinal pathways to terminate in the anterior horn cells of the lumbosacral cord segments subserving the plantar reflex.
- The downward CST fibers, normally keep the ascending sensory stimulation from spreading to other nerve roots. When there is injure to the CST fibers, nociceptive input spreads beyond S1 anterior horn cells. This leads to the L5/L4 anterior horn cells firing, which results in the contraction of toe extensors (extensor hallucis longus, extensor digitorum longus) via the deep peroneal nerve.
- Flexion reflex synergy called by Sherrington, because activation of all muscles affected shortening of the limb; the toe extensors forming part of this shortening synergy. The uncertainty has arisen from the application of the term plantar extensor response to a movement which forms part of a flexion synergy of the lower limbs. The toe 'extensors' named extensors by anatomists, are actually flexors in a physiological sense

because their action is to shorten the limb and contract reflexly along with other flexor muscles [6, 7].

Lesion in the Corticospinal Tract and Planter Reflex Response

- A lesion above the pyramidal decussation along the corticospinal pathway can modify the planter response on the contralateral side of the body (Contralateral Babinski sign).
- A lesion below the medullary decussation in the cord itself, modifies the planter response on the same side of the body (Ipsilaterla Babinski sign).

Table 1: Fallacies in the interpretation of the plantar response [5, 7].

	Lesion with Planter Response	Explanation
1	Damage to the pyramidal system may have a normal plantar response	Corticospinal fibres not only originate in different parts of the cortex, but also have diverse terminations. Only when lower limb fibres of the pyramidal tract are involved, Babinski sign can be expected.
2	An intact pyramidal tract may also cause an extensor response	It is due to dissociation of the nerve fibres in the spinal reflex arc, with excitation of the distal motor neurons and inhibition of the impulses via flexor reflex afferent nerve fibres, since they are mediated by different neurons.
3	Plantar areflexia in lesion of the first sacral cutaneous distribution	Loss of sensation of sole
4	Babinski response may not be observed in UMN lesions	There is complete paralysis of the extensors of the toes. In such cases, contraction of the tensor fasciae latae may be taken as a positive sign.
5	Bony deformities like ‘hallux valgus’ may prevent any movement of the big toe	In such a situation, it is important to observe the movement of the other toes.

Conclusion

In conclusion, the plantar reflex is a sensitive and reliable method for evaluating the integrity of the nervous system and motor pathways of the lower limbs. Interpretation of the plantar response is the most crucial step in predicting whether the response is pathological or not. Although, extensor planter responses may be a normal finding among infants, it is very vital to check the planter response in all children to rule out underlying lesions of the corticospinal tract.

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