Review Article

The articles of Babinski on his sign and the paper of 1898

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In 1896 Joseph François Felix Babinski described for the first time the phenomenon of the toes; nevertheless in this first paper he simply described extension of all toes with pricking of the sole of the foot. It was not until the second paper of 1898 that he specifically described the extension of the halluc with strong tactile stimulation (stroking) of the lateral border of the sole. Babinski probably discovered his sign by a combination of chance observation and careful re-observation and replication. He also had in mind practical applications of the sign, particularly in the differential diagnosis with hysteria and in medico-legal areas. Several of the observations and physiopathological mechanisms proposed by Babinski are still valid today, e.g., he realized since 1896 that the reflex was part of the flexor reflex synergy and observed that several patients during the first hours of an acute cerebral or spinal insult had absent extensor responses. He also found that most patients with the abnormal reflex had weakness of dorsiflexion of the toes and ankles and observed a lack of correlation between hyperactive myotatic reflexes and the presence of an upgoing halluc. He discovered that not all patients with hemiplegia or paraplegia had the sign but thought erroneously that some normal subjects could have an upgoing toe. Between 1896 and 1903 Babinski continued to think on the sign that bears his name and enrich its semiological and physiopathological value.

Key words: Babinski’s sign, flexor synergy, polysynaptic reflexes, upgoing toe


In 1896 Joseph François Félix Babinski (1857-1932) [Figure 1] in a very brief paper of 28 lines described for the first time the sign that bears his name[1] [Figures 2 and 3]. Robert Wartenberg commented thus about the Babinski reflex: “In its simplicity, clinical importance and physiological implications, Babinski’s sign has hardly an equal in medicine”.[2] Nathan and Smith[3] in 1955 wrote that it is probably the most famous sign in clinical neurology. At the time of the discovery of the sign, Babinski was 39 years of age. The article had no references and was written with brevity and clarity. It does not mention the number of patients he studied.

Figure 1: Joseph François Félix Babinski (1857-1932): Photograph and signature

Figure 2: Fanning of the toes, Babinski’s photograph. Notice that the fanning of the toes is also clearly seen in the shadow

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According to Wilkins and Brody and also Wartenberg, the sign had been previously described by Remak E, a German physician. It is doubtful that Babinski knew about the finding of Remak in 1896. Babinski’s paper was written in the first person and began with the sentence: “I have observed in some cases...”. This style leaves no doubt that he thought he observed the phenomenon for the first time. Remak’s paper had no impact in the neurological literature. Immediately after Babinski’s publications several papers appeared in different countries. Several facts should be mentioned about the 1896 paper of Babinski on the plantar reflex. First, he did not describe the upgoing of the hallux as the most important characteristic of the reflex. He observed that all toes would make an extensor movement after the “piqûre” (pricking) of the sole of the foot. Second, he compared, in patients with hemiplegia, the response of the toe in the affected side to the response in the sound side and thereby could very well contrast the difference; in other words, the sound leg served as control. Third, it is not clear whether Babinski stuck the sole of the foot once or several times or even if he dragged the pin along the sole of the foot. It does not even mention the part of the sole of the foot that was stimulated. Fourth, in patients with paraplegia or paraparesis he found that both feet had upgoing toes after the stimulation. Fifth, he observed that in all patients that had weakness of the lower extremity upgoing toes were present.

Since the first paper he recognized that the upgoing toe was part of a generalized flexion reflex. It is widely accepted that the Babinski sign (BS) is a modified form of the flexor reflex synergy and it appears when the polysynaptic flexor responses (PFR) are active or at least present. It is possible that in some patients with pyramidal tract (PT) lesions, the monosynaptic extensor responses are hyperactive, whereas the PFR remain depressed. On the other hand, Landau and Clare and Van Gijn showed that the muscles that produce the extension and flexion of the hallux with cutaneous stimulation are the extensor hallucis longus and the flexor hallucis brevis respectively. The contraction of the latter predominates under normal conditions and gives rise to a flexor response of the hallux. Van Gijn stated that patients with BS have weakness or clumsiness in the dorsiflexion of the great toe indicating that the PT that innervates monosynaptically the motoneurons of the extensor hallucis longus is damaged. If these specific supraspinal influences are not lesioned the BS may be absent even in the presence of a hemiparesis or paraparesis.

It has been known for a long time that dorsiflexion or extension of the great toe is, in fact, a physiological flexor response, whereas the plantar flexion is indeed a physiological extensor movement. Grimby demonstrated that nociceptive cutaneous stimulation (with a pinprick) of the ball of the hallux induces its dorsiflexion in normal subjects. This normal cutaneous reflex field extends in pathological conditions to the S1 dermatome or even farther. The BS is dynamic and may change over time. The size of the cutaneous afferent reflex field enlarges during the first few days or weeks after an acute cerebral lesion. The threshold of the reflex also changes with time. During an acute cerebral lesion the stimulus required to elicit it has to be strong, but after several days or weeks even tactile, non-nociceptive stimuli may induce it.

A follow-up of the time course of the BS over the months or years has never been undertaken. It is well known that spastic patients adopt over time an equinus position of the foot due to predominance of the tone of the physiological extensor muscles of the ankle; it is possible that at this stage the cutaneous-plantar response disappears. A study comparing patients with acute versus chronic lesions may shed light on this issue. The presence of a BS may be an exquisite indicator of a focal or diffuse cerebral lesion, but may be unexpectedly
absent in patients with an otherwise clear damage of the cortico spinal tract (CST).

In relation to the issue that the BS may or may not reflect damage or dysfunction specifically of the PT and its monosynaptic connections to the motoneurons of the extensor hallucis longus, it seems safer to say that, until proven otherwise, it reflects damage or dysfunction of several descending tracts or supraspinal influences on the lumbar L4, L5 flexor motoneurons and may also depend upon the time-course of the reflex, the excitability of the polysynaptic flexor responses and the relative excitability and tone of the plantar flexor muscles, particularly the flexor hallucis brevis.

The Article of 1898: On the Phenomenon of the Toes and its Semilogic Value

This was the longest paper written by Babinski and without doubt the most serious reflection he made upon the sign he discovered. In 1898 Babinski describes, for the first time, the upgoing hallux as the crucial part of the sign. He wrote: In certain pathological states, stimulation of the sole evokes extension of the toes, particularly the great toe. And a few words ahead: while flexion predominates in the last two or three toes, it is in the first one or two toes that extension is usually the most pronounced. In the 1898 paper Babinski describes and analyzes the phenomenon in diverse clinical situations. He clearly states that he has never found the sign in patients with hysterical weakness. This seems to have been one of the main applications that Babinski had in mind as he also mentions this in the paper of 1903. Babinski wanted a sign that could clearly distinguish hysterics or malingerers from those patients with damage to the central nervous system.

In this paper he also makes the remarkable observation that the sign may be absent in patients with acute paraplegia or hemiplegia with normal, diminished or even absent myotatic reflexes. In a patient he examined 24h after the onset of an acute hemiplegia the myotatic reflexes were of equal intensity in both lower extremities but an extensor response was present. He examined a patient one hour after the onset of the hemiplegia and found very weak myotatic reflexes on that side but a very prominent toe phenomenon. He also found that the sign was present in a patient with tabes who lacked all myotatic reflexes but had an acute cerebral lesion.

He observed that the degree of weakness was not in direct relationship to the intensity of the toe dorsiflexion: it may have been marked in certain cases where the hemiplegia was slight and where voluntary movement of the toe was not markedly reduced. On the other hand it could have been very marked, weak or even absent in cases where the paralysis was very pronounced. The Babinski reflex may be absent during the first few hours of an acute spinal cord transection. This observation also applies to acute cerebral insults. Babinski examined two patients with acute spinal cord transection. One was examined nine hours and the other three hours after the onset of the symptoms. He wrote of these patients: stimulation of the sole did not produce any movement. That means that the toe did not extend or flex. This response has been termed indifferent plantar response and most likely reflects a profound depression of the polysynaptic flexor responses and should be considered abnormal in most if not all patients. Van Gijn has considered that for the Babinski reflex to appear there must be two conditions: 1) some degree of excitability of the flexor polysynaptic reflex and 2) weakness of dorsiflexion of the hallux. Both, flexor and extensor responses of the hallux require some degree of excitability of the polysynaptic flexor responses. Absence of both flexor and extensor responses mean depression of the polysynaptic flexor reflexes (PFR) in flexor and extensor muscles of the toe. This decrease in the PFR seems to be the consequence of a sudden withdrawal of supranuclear excitatory influences. An absence of both flexor and extensor responses in the first few hours of a hemiplegia or paraplegia should probably be regarded as abnormal and carefully followed up. A “neutral” Babinski response may be observed during spinal shock and in patients with severe flaccid paralysis due to peripheral nerve damage. The intensity of the stimulus required to produce an upgoing toe in the first few hours of an acute cerebral injury is high. The intensity that induces the reflex decreases over time. In other words the threshold is high in the first few hours and decreases over the following days. The size of the cutaneous afferent field from which the Babinski reflex can be elicited is at the beginning confined to the S1 dermatome and gradually impinges upon the neighboring dermatomes L4, L5, S2 and S3. In a patient with a facilitated BS this can be obtained with stimulation of any part of the sole. In newborn children the BS can be obtained with stimulation of the calf, the thigh and even the abdomen. In this paper our author also described that some patients with diffuse cerebral dysfunction may have upgoing toes. This has been borne out in several studies. Nevertheless the sensitivity and specificity of the BS in diffuse cerebral diseases has not been elucidated to our knowledge. In a post-ictal patient he found a transient upgoing toe. The BS has since been found transiently in a great number of conditions including metabolic encephalopathies, in Cheyne-Stokes respirations during the apneic phases, deep sleep stages and intoxications with several drugs.

The Paper of 1903: On Abduction of the Toes

This is also a very short paper almost as short as the
We examined 100 patients with hemiplegia or paraplegia. Oliveira-Souza and de-Figueiredo have argued that many scientific discoveries are made fortuitously, right in the other two assertions. Leaving aside the fact that he does not mention the author he is most likely fortuitous and also makes the statement that Remak did of the author and dismisses the finding as incidental or toe before him. However, he does not mention the name at this point that E. Remak had described the upgoing polysynaptic flexor responses are depressed. This when there is a flaccid hemiplegia, spinal shock, when in the first few hours of acute cerebrovascular events, continues to be perplexing. The BS may be absent during the first 24h of the onset;[33] absence was observed by us in 3/5 patients with an acute hemiparesis or paraparesis.[33] This fact however. In two patients with long-standing familial spastic paraparesis the BS was absent on repeated examinations. The sign was never present in normal subjects. Babinski makes the point that it is frequently seen in patients with a “disorder or the pyramidal system, in patients with congenital spastic paralysis and... in newborns in whom the pyramidal system has not been fully developed”. This last finding admits no controversy.[34] The extensor response disappears shortly before locomotion is achieved.[13] Therefore in phylogenetic terms the extensor response represents a regression to a very early stage of development when locomotion is not present.[34] However, the assertion that the BS always represents a specific disorder of the PT has been hotly discussed.[3,15] The issue as to whether the BS is specific of a PT lesion, has been long debated. The controversy of Nathan and Smith[3] with Francis Walshe illustrates well this point. In a study of the spinal cord of 38 patients that had undergone a cordotomy Nathan and Smith found a lack of correlation between PT injury and the sign of Babinski. Francis Walshe emphatically denied this assertion but showed no statistical or anatomical data. Van Gijn[21] has stated that patients with a BS have weakness or clumsiness in the dorsiflexion of the great toe indicating that the PT that innervates monosynaptically the motoneurons of the extensor hallucis longus are damaged. Lundberg, on the other hand, has suggested that is related specifically to damage to the PT and adjacent cortico-reticulospinal fibers. If these specific supraspinal influences are not lesioned the BS may be absent even in the presence of a hemiparesis or paraparesis. This is probably the best evidence that the extensor response is related specifically to PT damage or dysfunction.

Finally, Babinski states that he had recently seen a “case of a crural paraplegia due to trauma, which motivated a medico-legal evaluation; the physicians charged with the examination were of the opinion that they were dealing with hysteria or malingerering because the classical objective signs of organic disease of the nervous system were absent. Having observed in this patient a very distinct abduction of the toes, I gave a contrary opinion”. This discussion supports the view of Oliveira-Souza and de-Figueiredo that he thought his sign could be used for medico-legal purposes. Babinski ends the paper stating that his finding is “a sign of probability in favor of a dysfunction of the pyramidal system. This can be valuable in certain doubtful cases”. When he says that it is a “sign of probability” he is actually asserting that the sign is not present in all cases of hemiplegia or paraplegia. He proved to be right in this point because the sensitivity of the Babinski reflex is not one hundred percent.

Recent papers have focused on what is valid today of Babinski’s original observations seen with the vantage point of 100 years of distance,[30,36,37] the relationship of...
the Babinski sign to the Chaddocks’ sign,[38] the interest of Babinski in his sign in neurosurgical cases,[39] the pathophysiology of the abnormal reflex,[40] some aspects of historical interests[37,38,41] and its semantic value.[42]

The classical van Gijn monograph still remains worthy of consultation.[43]

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