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Review article

Positive signs of functional weakness

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ABSTRACT

Functional (conversion) neurological symptoms represent as one of the most common situations faced by neurologists in their everyday practice. Among them, acute or subacute functional weakness may mimic very prevalent conditions such as stroke or traumatic injury. Hence, accurate and reliable positive signs of functional weakness are valuable for obtaining timely diagnosis and treatment, making it possible to avoid unnecessary or invasive tests and procedures up to thrombolysis. We therefore present here a brief overview of the positive neurological signs of functional weakness available, both in the lower and in the upper limbs, moving from a historical perspective to their relevance in current clinical practice.

Contents

1. Introduction

Functional (conversion) neurological symptoms are a longstanding and still unresolved issue, being one of the most common situations encountered by neurologists during their everyday practice [1]. Among functional symptoms, a special place is devoted to those mimicking very prevalent conditions that might present in emergency situations, such as stroke or traumatic injury [2]. Correct recognition of functional weakness, therefore, acquires special significance, and devising reliable positive neurological signs to identify it should have high priority. Interestingly, this issue was most keenly felt when neurology first emerged as a clinical speciality, in that very long pre-imaging period which saw the question of how to distinguish between "organic disorders" and functional ("hysteric") ones not only as a major problem, but also as presenting a specific role for neurological semiotics [3]. The illustrious French neurologist Joseph Babinski (1857–1932) devoted much of his career to devising signs useful for distinguishing the two

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conditions [4–6], and he addressed the matter also in the description of his most famous sign, "le phenoméne des orteil" ("the phenomenon of the toes") [7,8].

As already known, the absence of organic signs in paresis (a negative sign) does not exclude the presence of an organic disease. In fact, the lack of a sign of organic paresis can be explained by several other reasons, including intermediate phenotypes, *forme fruste* expressions and, even methodological issues [9]. From this perspective, *positive* signs of functional weakness (thoroughly reviewed in [10]) might acquire a special value, even though the question of how to reach a diagnosis of "hysteria" (by *inclusion* or by *exclusion*, i.e., either by the presence of specific "functional" signs or by the absence of equally specific "organic" signs, respectively), is as old as Neurology itself with the famous clash between two such eminent physicians as Chavigny and Babinski [8]. Even nowadays, then, building up knowledge regarding a specific semiotics for positive signs of functional weakness might be of value, because of the pressure on clinical neurologists to reduce costs while guaranteeing reliable diagnoses.

2. Positive signs of lower limb functional weakness

First described in 1908 [11], the Hoover's sign is still the commonly described positive sign for detecting functional paresis at the lower limb. It was named by Lhermitte (1877–1959) after the American physician Charles Franklin Hoover (1865–1927) who gave his name also to a later sign used in pulmonology, his main field of interest, for detecting chronic obstructive pulmonary disease [12,13]. Hoover's neurological sign indicates functional weakness of leg extension by taking advantage of the basic principle of contralateral synergic movement (complementary opposition), used repeatedly for developing positive signs of functional weakness. Notably, Koehler and Okun [14] recently documented the context in which the development of the Hoover's sign occurred. The key concept enabling Hoover to come up with his sign was probably the "*Ersatzphenomän*", or "substitution phenomenon" of Bychowski [15]; this was independently reported by Grasset and Gaussel [16] too, closely resembling the earlier "*Ersatzbewegungen*" ("substitution movements") formulated by Babinski who described the trunk–thigh test, also known as "*the rising sign*" [17]. Both concepts are related to the clinical observation of synkinetic oppositional movements during the execution of specific maneuvers in hemiplegic patients. The idea of taking advantage of their involuntary nature in order to unmask functional weakness is what lies behind the later Hoover's sign.

In clinical practice, the Hoover's sign is characterized by an involuntary extension of the weak leg when the contralateral limb is forced to flex against resistance and it is perceived by the examiner's hand placed under the heel (positive Hoover's sign; Fig. 1). Unperceived downward pressure of the good heel when trying to lift the weak leg in functional cases represents the complementary way of recording the information [11,18]. Moreover, Hoover himself reported the possibility of inverting the procedure in order to obtain similar information by asking the patient to press his/her leg against the couch instead of lifting it [11].

A recent formal attempt at assessing the validity of the Hoover's sign in a clinical setting was carried out by a UK-based group [19]. In this unblinded study, 8 patients out of 124 with suspected stroke had a diagnosis of functional leg paresis and Hoover's sign displayed moderate sensitivity (63%) and high specificity (100%), close to that previously reported in a cohort of 107 patients with functional neurological weakness [20]. Moreover, various attempts have been made to increase the external validity of this sign by performing objective measurements instead of relying on the examiner's perception, some going back more than 50 years, using both simple scales and EMG aimed at detecting pressure and muscle activity, respectively [21]. Recently, Diukova and colleagues [22] compared patients (n = 9 for each group) presenting with functional leg weakness, stroke with leg paresis, painful lumbar radiculopathy and healthy controls. Hoover's maneuver

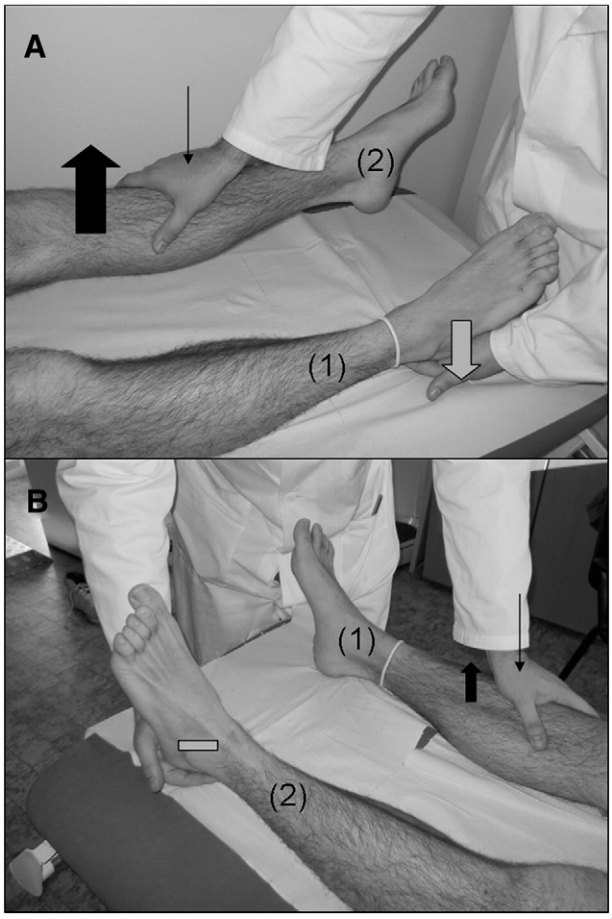

Fig. 1. Hoover's sign. (A) An involuntary extension of the paretic leg [(1) marked with a white elastic] is perceived by the examiner's hand placed under the heel when the contralateral limb (2) is forced to flex against resistance (positive Hoover's sign); (B) the unperceived downward pressure of the strong heel (2) when trying to lift the weak leg (1) represents the complementary way of recording the information. Often this part of the sign is overlooked. See Ref. [11]. Black arrow, voluntary movement; gray arrow, involuntary movement; gray bar, lack of involuntary movement; thin arrow, resistance applied by the examiner.

was performed by two clinicians other than the main carer, by placing weighing scales under the heel of both legs in order to obtain a quantitative evaluation of the cognate sign. "Hoover's index" is described as the ratio between the involuntary and voluntary pressures, with higher values indicating a "more" positive Hoover's sign. The ratio between the pressures of the affected and non-affected leg is also proposed as the "side index". Performing this modified Hoover's procedure, the authors reported that both sensitivity and specificity reached 100% and they formulated a cut-off value (1.4) for the Hoover's index. A previous work similarly proposed the quantification of Hoover's test by computerized quantitative myometric evaluation, clearly differentiating 9 functional patients from 7 patients with "organic" weakness (5 affected by stroke and 2 by motor neuron disease) as well as from 10 healthy controls [23]. Interestingly, in this latter work, appraisal of Hoover's phenomenon was extended to include the upper limbs as well, demonstrating the same pattern as for the lower limbs.

Some limits of the Hoover's sign [24–26] in terms of false positive results [27] and caveats [21,26] have been reported by various authors, mainly regarding the correct interpretation of mildly positive signs, especially in the setting of marked spasticity, pain, cortical neglect or even in normal individuals. Modifications for overcoming these limits have also been suggested, such as substituting the examiner's hand under the heel with direct palpation of the contralateral thigh muscles [26]. A modified procedure is even proposed in Adams and Victor's reference

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