NEUROLOGICAL SIGN

Hoover's sign

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The great beauty of Hoover's sign is that it relies on the absence of a normal phenomenon found in most people and not the presence of an abnormal phenomenon such as the Babinski sign.

BACKGROUND AND HISTORY

It's the middle of the clinic. Your next patient has a bulging set of case notes and struggles in to the room on two elbow crutches with a hand-written list of 15 somatic complaints. The worst symptom is progressive right leg weakness that has become so bad that any work has been impossible for six months. You have already noted some physical signs. The right leg is dragged like a sack of potatoes and when the patient climbs on the bed the leg is hauled on with both hands. On direct testing there is some 'collapsing weakness' even after you've cajoled and encouraged the patient. The reflexes are normal. How are you going to clinch the diagnosis of functional weakness? Can Hoover's sign help you?

Time to get some definitions straight. In this article we will use the term functional weakness to refer to medically unexplained weakness of the type that was formerly labelled 'hysterical', i.e. the patient is unaware or largely unaware of any degree of control over the symptom. As we will comment later, Hoover's sign does not help differentiate this type of weakness from deliberately simulated weakness, which in our experience is a much rarer problem outside medico-legal scenarios.

Dr Charles Franklin Hoover (1865–1927), a physician in Cleveland, Ohio, described his useful principle and two tests in the *Journal of the American Medical Association* in 1908 (Hoover 1908). According to Pryse-Philips 1995, Hoover trained as a Methodist minister before medical studies at Harvard, Vienna and Strasbourg. He later became professor of medicine at Western Reserve University, Ohio specialising in pulmonary and hepatic disease. His neurological test should not be confused with a respiratory 'Hoover test', which relates to paradoxical movement of the rib cage in pericardial effusion. His article 'A new sign for the detection of malingering and functional paresis of the lower extremities' (Hoover 1908) was based on four patients seen in two years. Hoover's sign, like the type of patient for whom it is intended, has not traditionally been popularised in neurological training or textbooks and yet it is one of the most useful and simple tests in this area.

HOOVER'S SIGN

Hoover's two tests rely on the following principle – try it if you don't believe us. If a healthy person, lying or sitting down, flexes their right hip, they will automatically extend their left hip. This also occurs in hemiparesis due to an upper motor neurone lesion – where hip extension is invariably well preserved – and in patients who have functional weakness.

This basic principle can be used to aid diagnosis in two main ways – both described by Hoover:

• For a patient with weakness of hip flexion: Ask the patient to flex their weak leg at the hip. In normal people and in patients with an organic hemiparesis you will feel downward pressure under the opposite heel. If you feel nothing it suggests a functional weakness, i.e. that effort is not being transmitted to either leg. This sign can be used even if both legs are weak but is probably less reliable than the next test.
• For a patient with weakness of hip extension: You have already found weakness of hip extension on direct voluntary testing. Ask the patient to flex their good leg against resistance while keeping your hand under the heel of the weak leg. If you feel downward pressure that was not there before you have palpable evidence of inconsistency in the examination. (Fig. 1).

The great beauty of Hoover's sign is firstly, that it relies on the absence of a normal phenomenon found in most people and not the presence of an abnormal phenomenon (such as the Babinski sign). Secondly, it is a clinical marker of internal inconsistency that can be repeated in a controlled way and does not rely on skilled surreptitious observation. Thirdly, and perhaps more controversially, it is a physical sign, which if carefully handled, can be used to demonstrate to the patient their own potential for recovery.

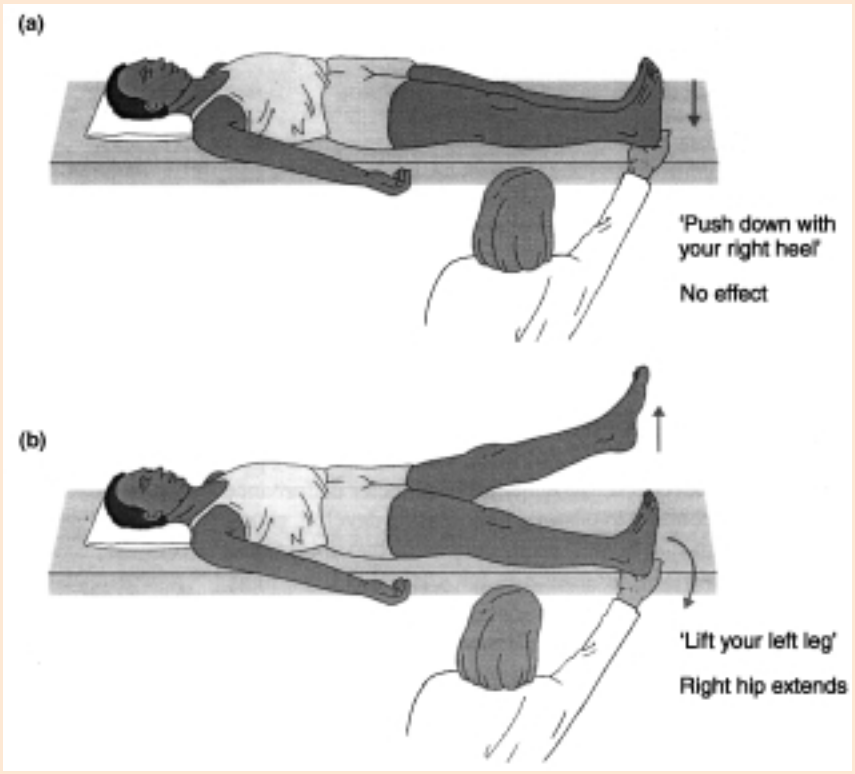

Figure 1 Hoover's sign – how to do it. (a) The patient is unable to extend the hip and to press the heel into the bed on request. (b) The hip is extended involuntarily when the opposite leg is lifted off the bed. Reprinted from Neurology: an illustrated colour text, Fuller and Manford, p116, 1999, by permission of the publisher Churchill Livingstone.

PHYSIOLOGY

Why does this phenomenon exist? A simple answer might be that for every action there is an equal and opposite reaction. Imagine you've just stepped on a pin. Because you have probably lifted and flexed your leg, it helps if the hamstrings of your other leg contract and keep you planted on the floor. Walking is more complicated but does rely on this basic response. Sherrington first described and named this the crossed extensor reflex (Sherrington 1910). He demonstrated its presence even in decerebrate and spinal cord animals. The pathway for this reflex involves excitatory spinal interneurones, which traverse multiple levels of the spinal cord before producing an antagonistic contraction in the opposite limb.

THREE IMPORTANT CAVEATS

Like any physical sign it is important not to get too carried away by Hoover's tests.

1 A positive Hoover test does not exclude dis-

ease. It simply suggests that the majority of the weakness you are observing is not due to disease. Weakness in organic disease like multiple sclerosis may be exaggerated for a number of reasons: for example the patient is not sure whether you believe them and wants to prove they are weak, the patient is distressed and finds it hard to exert maximal effort, or they do not understand your instructions.

2 A positive Hoover test does not tell you if the person is 'putting on' the weakness. There is still no reliable way of differentiating those patients who are deliberately deceiving you from the majority of patients who have little conscious control over their leg weakness. This difficult judgement has to be based on other criteria which are hard to come by, such as evidence of lying in the history, video surveillance or a clear desire for substantial monetary gain.

3 Be careful in the presence of pain. Pain may affect the sign in several ways. Arieff reported a patient with 'left sciatic radiculitis' who had a positive Hoover test in their normal leg (Arieff 1961). The downward pressure exerted by their normal leg was greater when they tried to lift their painful leg than when they had performed it in isolation. They interpreted this as increased effort to aid the movement of a painful limb. Conversely, a patient may be consciously reluctant to move a painful, leg which could create a false positive test in the affected limb. Hoover's has been described as a test for 'nonorganic' sciatica (Zalejski 1967) but we would not recommend this.

VALIDITY

We are aware of only four subsequent papers on Hoover's sign used to detect weakness. Arieff *et al*. 1961 examined the Hoover principle in several patients with functional weakness using EMG and what amounts to a set of bathroom scales but did not reach new conclusions. Archibald & Wiechec 1970 carried out a similar study in 12 normal patients, six organic hemiparetics, 11 patients with 'various neuromuscular disabilities' and two with functional weakness. The study is disappointing because they only provided data on one comparison between functional and organic weakness and only examined Hoover's test for weakness of hip flexion. They found retest and between-patient inconsistencies in the normal and organic groups ('a reliablity coefficient of 0.56') when measuring downward heel pressure during contralateral leg raising. This variation is hardly surprising given the population being studied, but it doesn't help at all in validating the test in patients with functional weakness, for whom the test is intended.

More recently, Ziv *et al*. 1998 carried out a controlled study of Hoover's sign in nine patients with functional limb weakness, seven with organic causes for weakness, and in 10 healthy controls. They refined the test using computerized myometry – essentially a strain gauge measuring voluntary vs. involuntary hip extension as described above. They found this method could discriminate impressively between 'nonorganic' and 'organic' leg weakness when applied to a 'gold standard' of clinical diagnosis backed up with laboratory and imaging investigations (Fig. 2). Diukova *et al*. 2001 have recently replicated this finding in nine subjects using simple weighing scales. In this study, comparison groups with back pain, neurological weakness and healthy controls were significantly discriminated against. We must bear in mind though that neither of these studies were blinded and even weighing scales do not necessarily equate with busy clinicians using the sign in the real world. Clearly more work is needed.

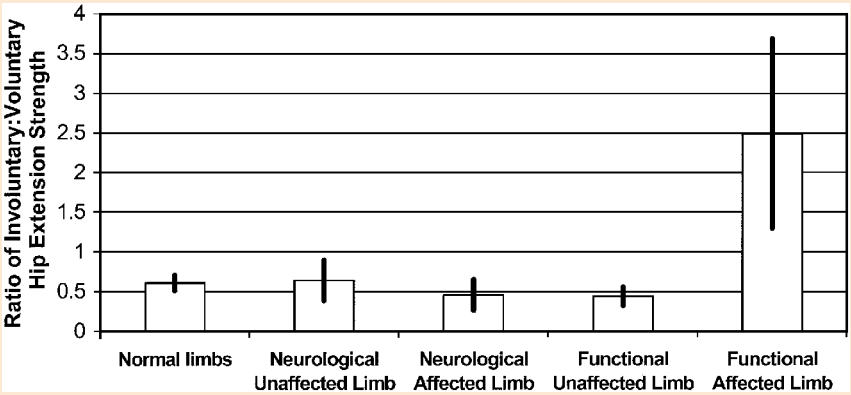

Figure 2 A controlled study of Hoover's sign – figures adapted from Ziv *et al*. 1998. A unique discrepancy is observed in the affected weak limbs of patients with 'nonorganic' weakness, in contrast to their unaffected limb, normal controls and patients with 'organic' weakness (Error bars represent 95% confidence intervals).

HOOVER'S SIGN IN THE ARMS?

Hoover commented that the phenomenon of 'complementary opposition' is also present in the movements of shoulder abduction and adduction although admitted it is less reliably so. Ziv *et al*. 1998 investigated this with

their technique. They obtained similar results to those in the leg but it remains to be seen whether this result can be repeated or translated into clinical practice.

OTHER PHYSICAL SIGNS OF FUNCTIONAL WEAKNESS

How does Hoover's sign measure up to other competing signs? In his original article, Hoover commented that he had 'found Babinski's sign unsatisfactory' in relation to making a positive diagnosis of functional weakness (Hoover 1908). Babinski would have been the first to point out that his sign is absent in numerous organic causes of leg weakness, such as myopathy and radiculopathy, and therefore had good specificity but poor sensitivity for excluding functional weakness. Collapsing weakness has been investigated on a few occasions over the years in neurophysiological ways (McComas *et al*. 1983; Knutsson & Martensson 1985; van der Ploeg & Oosterhuis 1991), but not as a clinical sign. One of the very few studies to look at the frequency of collapsing weakness in neurological populations was carried out by Gould *et al*. 1986. In a salutary if crude paper, a third of 30 patients with acute organic neurological problems (mostly stroke) had collapsing weakness on admission – no doubt due to a variety of reasons such as pain, general illness and difficulty following instructions.

HOOVER'S SIGN AS A THERAPEUTIC PROCEDURE?

In the course of examining many patients with functional weakness we have recently found that some patients are interested to know precisely how we arrive at our diagnosis. In several patients, the demonstration of their own Hoover's sign has allowed the patient to see that, under some circumstances, they are able to achieve greater power in their affected leg than they thought possible. Handled carefully, this seems to help their understanding of the problem, their belief that their leg can get better, and improves transparency and trust between doctor and patient. Handled badly, the patient may well interpret your explanation as 'Gotcha!'. Therein lies the challenge.

CONCLUSIONS

Hoover's sign is an easy sign to learn and use. Once learned, it will not be long before you have an opportunity to try it out on someone – in the light of a thorough history of course. None of the physical signs of 'functional' weakness has much more to commend it than common sense. In our opinion Hoover's sign is, despite all our caveats, the most useful.

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