Journal of Neurology, Neurosurgery, and Psychiatry 1991;54:248–251

The "make/break test" as a diagnostic tool in functional weakness

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Abstract

Strength was measured in four major muscle groups with a hand-held dynamometer. The "make" and "break" technique was used with and without encouragement, and fatiguability was tested in patients with organic weakness and patients with functional weakness. Patients with functional weakness could be distinguished from the other two groups by an increase in strength >20% with the break compared with the make technique. Additionally they tend to show larger increases in strength with encouragement and their "fatiguability" was less.

A neurologist is frequently confronted with patients who complain about exercise intolerance or fatigue. If manual muscle testing shows reduced strength without any other neurological abnormalities the question arises as to whether it has an organic or a functional origin. Functional weakness may be a conversion symptom. A conversion symptom is defined as a relatively persistent loss or alteration in sensory or motor functioning that cannot be explained by known physical disorders or pathophysiological mechanisms.[1] When the symptom occurs in isolation, there is a conversion disorder. According to Marsden[2] hysterical symptoms account for about 1% of neurological diagnoses and approximately one third of these patients show motor dysfunction.

The functional characteristic of a paresis can often be suspected on clinical grounds, because of a discrepancy between manual and functional tests, unsustained contractions giving way abruptly, or palpable contraction of antagonists.[3] Nevertheless, it remains difficult to determine, on clinical grounds alone, that a paresis is functional. To distinguish organic weakness and functional weakness dynamometry was applied with different test techniques. Healthy volunteers and patients with organic and non organic paresis were tested.

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Received 17 May 1989
and in final revised form
22 May 1990.
Accepted 7 July 1990

Methods

Maximum voluntary contraction was measured with the myometer[4] (Penny and Giles Transducers Ltd, Dorset, UK), which was modified by removing the peak hold to give a continuous registration of strength. The myometer was connected to a Siemens Mingograph Recorder with a paper speed of 5 mm/s and an amplitude 50 N/cm. A graphical representation of each contraction was made.

Four muscle groups were tested: elbow flexors and extensors, hip flexors and knee extensors. Normal subjects and patients received the instruction to build up maximal strength in one to two seconds. Every muscle was tested 10 times with intervals of five seconds in a standard position with the patient supine (see table 1). Different test techniques were applied in a strict order (table 2). There were five tests with the "make" and five with the "break" technique. In a make test the examiner gives resistance to the force of the patient, under static circumstances. In a break test the examiner gradually overcomes the muscle force and stops at the moment the extremity gives way. Both tests take one to four seconds. During two make and two break contractions there was verbal encouragement (E); the other tests were performed without encouragement. For each muscle the following was calculated:

Break Index (BI) =

$$\frac{\text{F Break} - \text{F Make}}{\text{F Make}} \times 100\%$$

Encouragement Index (EI) =

$$\frac{\text{F with E} - \text{F without E}}{\text{F without E}} \times 100\%$$

Fatigue Index (FI) =

$$\frac{\text{F1,2} - \text{F9,10}}{\text{F1,2}} \times 100\%$$

(F1,2 are the first two and F9,10 the last two contractions)

All measurements were carried out by the first author. One group of healthy volunteers and three groups of patients were measured (see table 3).

Group 1 consisted of 20 healthy volunteers, mostly hospital employees. The muscles which fell within the range of the dynamometer, 0–300 Newton (N), were measured.

Group 2 consisted of 20 patients with a clinical diagnosis of functional weakness. The muscles which had a functional disturbance were tested. All but one patient had normal EMGs and all had normal serum creatine kinase and thyroid function. Apart from "muscle weakness" there were no other neurological abnormalities and no pain which could influence a maximum voluntary contraction. One patient had a slight polyneuropathy on electromyography, which could not be

Table 1 Standard positions for muscle groups tested

Muscle group	*Subject position*	*Dynamometer position*
Elbow flexors	Supine; shoulder adducted, elbow 90° flexed, forearm supinated	Just proximal to wrist crease (flexor surface)
Elbow extensors	As for elbow flexors	Just proximal to wrist crease (extensor surface)
"ip flexors	Supine; hip and knee 90° flexed, ankle supported by examiner	Anterior surface of distal thigh
Knee extensors	Prone; knee 90° flexed	Anterior surface of distal shunt just proximal to ankle joint

Table 2 Order of test techniques

1 Make
2 Break
3 Make with encouragement
4 Break with encouragement
5 Break
6 Make
7 Break with encouragement
8 Make with encouragement
9 Make
10 Break

regarded as sufficient explanation for the severe weakness. All patients were followed for at least six months and no new signs appeared.

Group 3 consisted of 20 patients: 10 with neuromuscular disorders (three ALS, two myasthenia gravis, two Guillain-Barré syndrome, one polymyositis, one spinal muscular atrophy and one radicular lesion L4) and 10 patients with central motor disorders (three cerebrovascular accident, three Parkinson's disease, two intracerebral tumour, one spinal arteriovenous malformation and one multiple sclerosis).

Group 4 consisted of 20 patients with muscle weakness investigated by the examiner who was unaware of the diagnosis; nine patients had organic diseases (without obvious signs like myopathic facies or hemiplegia) and 11 had functional weakness as judged by an experienced neurologist. On the basis of the results and the experience with groups 1–3 it was possible to classify the weakness of these patients into organic weakness and functional weakness.

Table 3 Subject information

Group	*Number*	*Female*	*Male*	*Mean age (year)*
1 Normal subjects	20	14	6	32
2 Organic weakness	20	13	7	51
3 Functional weakness	20	13	7	39
4 Mixed weakness (see text)	20	9	11	43

Table 4 Results of tests in normal subjects and patients with organic and those with functional weakness expressed in mean break index (BI), encouragement index (EI) and fatigue index (FI), (minimum, maximum). See methods for explanation of BI, EI and FI

	n	*BI*	*EI*	*FI*
Normal				
Elbow flexors	16	3 (0, 6)	2 (−3, 12)	5 (−7, 19)
Elbow extensors	20	3 (−2, 11)	2 (−3, 10)	4 (−9, 14)
Hip flexors	13	3 (−6, 10)	2 (−5, 13)	−5 (−24, 11)
Knee extensors*	—	—	—	—
Total	49	3 (−6, 11)	2 (−5, 13)	2 (−24, 19)
Organic weakness				
Elbow flexors	8	11 (−17, 61)	9 (−3, 39)	2 (−33, 24)
Elbow extensors	12	3 (−4, 12)	1 (−4, 4)	7 (−19, 40)
Hip flexors	16	6 (−5, 23)	−3 (−11, 9)	2 (−26, 31)
Knee extensors	9	5 (−1, 13)	8 (−1, 30)	−1 (−44, 35)
Total	45	6 (−17, 61)	3 (−11, 39)	2 (−44, 40)
Functional weakness				
Elbow flexors	10	76 (28, 158)	16 (1, 48)	−24 (−210, 27)
Elbow extensors	5	70 (42, 98)	19 (0, 63)	−15 (−42, 16)
Hip flexors	19	81 (37, 245)	6 (−5, 64)	−1 (−54, 62)
Knee extensors	15	68 (23, 131)	17 (0, 42)	−14 (−98, 25)
Total	49	75 (23, 245)	13 (−5, 64)	−11 (−210, 62)

*All knee extensors of normals were too strong to measure.

Results

The BI, EI and FI of group 1–3 can be seen in table 4 and in fig 1. In normal subjects the BI is on an average 3% (min −6%, max 11%), in organic weakness 6% (−17%, 61%) and in functional weakness 68% (23%, 245%). The mean EI in normal subjects is 2% (−5%, 12%), in organic weakness 3% (−11%, 39%) and in functional weakness 13% (−5%, 63%). The FI is on average in normal subjects 2% (−24%, 19%), in organic weakness 2% (−44%, 40%) and −11% (−210%, 62%) in functional weakness.

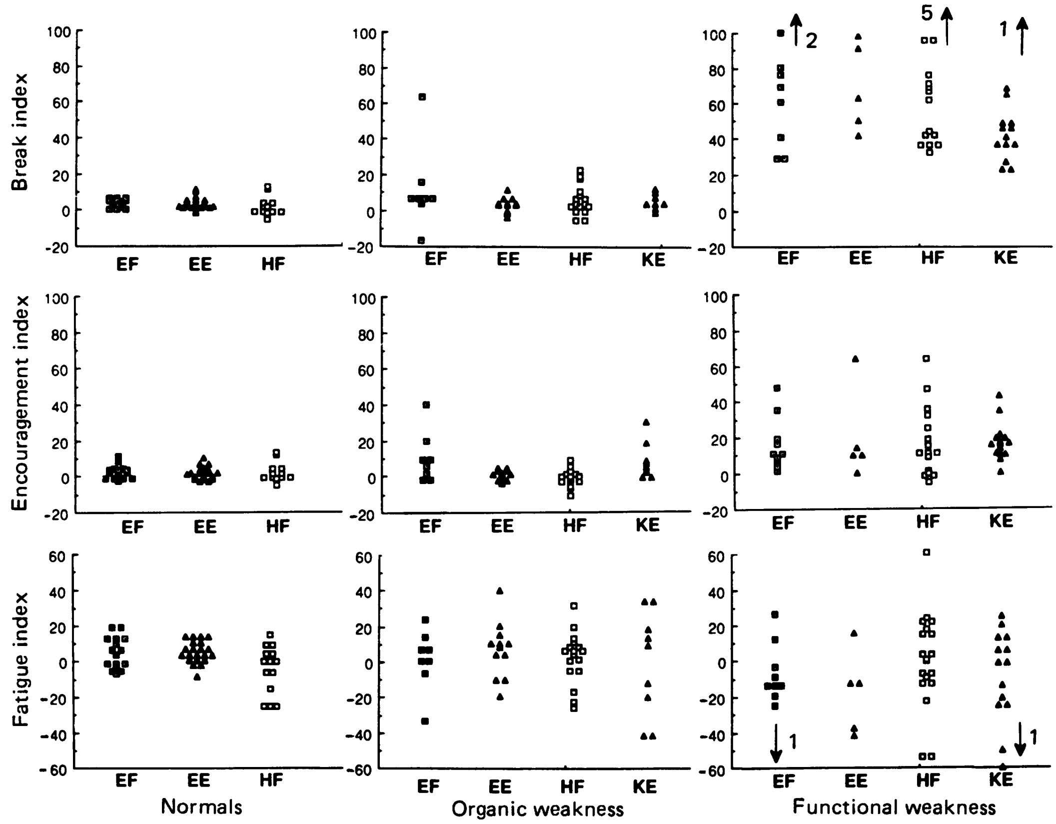
The graphical representation showed a consistent form of the maximum voluntary contraction in the normal group and in 18 patients with organic weakness. Two patients with organic weakness, one with ALS and one with myasthenia gravis, showed irregular contractions. All but three patients with functional weakness showed irregular, inconsistent contraction forms. Examples of these graphical representations can be seen in fig 2, with the addition of the fifth centile values of normal volunteers of 20–60 years of age.[5] In 61% of the cases of functional weakness strength was more than the fifth centile value, especially in break, and break with E contractions.

Group 4 was tested without previous knowledge of the disease. The criteria for functional weakness were a BI and/or a EI >20%. In 19 out of 20 cases there was a correspondence between the established diagnosis and the diagnosis on the basis of the dynamometer results.

Discussion

Our results show many differences between functional weakness, organic weakness and normal volunteers. Most striking is the influence of the break technique. In healthy volunteers there is only a small increase of 3% (SD 3·0%) in power with the break technique compared with the make technique. The make technique involves an isometric contraction and the break technique an eccentric contraction. It is well known that eccentric contractions produce higher forces, especially when the speed of the eccentric movement is high.[6] We carried out the break test with a slow speed so that the increase is only small. In patients with organic weakness the break index is slightly higher (mean 6·0%) than in normal

Figure 1 Diagram showing the Break, Encouragement and Fatigue Indexes in normal subjects, patients with organic weakness, and patients with functional weakness. The number next to the arrows indicates the number of muscles, which exceeded a Break Index of 100 or a Fatigue Index of −60. (EF: elbow flexors, EE: elbow extensors, HF: hip flexors, KE: knee extensors).



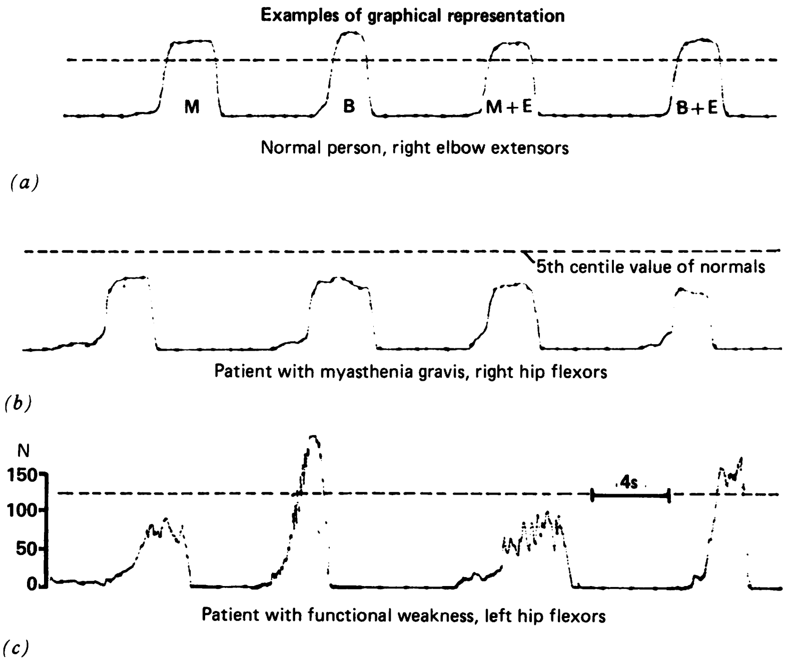


Figure 2 Examples of graphical representation of the maximum voluntary contraction. M stands for make, B for break, M + E for make with encouragement, and B + E for break with encouragement. See text for explanation of "make" and "break".
The dashed line indicates the fifth centile value of normal subjects, age range 20 to 60 years.
(a) shows the contraction of the right elbow extensors of a healthy volunteer.
(b) represents the contractions of the right hip flexors of a patient with myasthenia gravis. As can be seen the force level is below the fifth centile value of normal, but the form of the curve is very similar to (a).
(c) show the contractions of a patient with functional weakness in the right hip flexors. During break tests the force level exceeds the fifth centile value of normals, while the results of the make tests are well below this value The curve is very irregular.

volunteers, but in functional weakness all patients have a large break index, up to 200%, mean 68% and all cases above 23%. Moreover, with the break test 61% of the 20 functional weakness patients appeared to have strength within "normal limits" (within fifth centile of normal). An eccentric movement is apparently an important stimulus to produce real maximum voluntary contraction.

A possible explanation is that the antagonist is shortened and the activation of its muscle spindles is nil. In the agonist there is a powerful activation of the spindles.[6] During an eccentric contraction (a break test) it is difficult to activate the antagonist and not to activate the agonist. It is well known that the break test is better understood by patients who are unable to cooperate fully,[3] perhaps because of the same reason. For this view functional weakness is essentially a form of poor cooperation. In the group with organic weakness only one patient with a spastic hemiplegia and disturbed comprehension showed a large increase (61%) with the break test, but in contrast to patients with functional weakness she had evident neurological disease.

Encouraging normal patients or those with organic weakness gives only a slight increase in muscle strength (EI in normals 2% (SD 3·8%)) which compares well with the results of Peacock *et al* who found an increase of approximately 4% with auditory encouragement.[7] In a grip strength study there was no significant influence of auditory feedback.[8] In patients with functional weakness we saw a large increase with encouragement (>20%) in 27% of the cases. In only two out of 94 muscles (2%) was an EI > 20% seen in normal patients and those with organic weakness.

Although many patients with functional weakness complain about fatigue the FI is varying to a large degree, even within one patient and in the mean there is even an increase in strength. This is a well known clinical finding in functional weakness,[3] but it does not distinguish these patients from the group with organic weakness, as can be seen in fig 1. Normal subjects show a small degree of fatigue, mean 2%. Patients with organic weakness show a larger decrease in strength (a higher FI) especially in the case of myasthenia gravis, which confirms the findings of Nicklin.[9]

The form of the curves was very consistent in all normal volunteers with a gradual increase in strength to maximum voluntary contraction in one to four seconds, so this seems to be the normal curve with the instruction given (fig 2). Most patients with organic weakness had essentially the same curve but two patients had a very irregular form (one myasthenia gravis patient, one ALS patient) and there was a slightly tremulous contraction. In patients with functional weakness we saw an irregularity of the curve in 17 patients, which sometimes corresponded to the jerking contractions. However, the difference between irregular and normal is somewhat subjective. In some cases there was a very slow increase (>4 s) in strength.

In the case of non organic weakness it would be expected that there would be large variations with repeated measurements, but when only one technique is used, for instance make, the variation is mostly within the same limits as in normal subjects. Voluntary static muscle force on a level below maximum voluntary contraction can be repeated with a degree of precision of approximately 10%.[10] A malingerer would be able to score very consistent, subnormal results, if only one technique is used. It is the combination of different test techniques, which reveals functional weakness.

In healthy volunteers the results of all four muscles in terms of standard deviation, BI, EI and FI did not differ to a large degree, which makes it probable that other muscles behave essentially in the same way. The same applies to all four muscles of organic patients for the influence of BI and EI. Although not systematically done, in a third of the patients with functional weakness the contralateral ("normal") side was tested and the results fell within the range of normals as to BI, EI, FI and form of the curve.

A consistent or even inconsistent maximum voluntary contraction with a BI and EI <20% and a subnormal value indicate with certainty an organic paresis. Does a BI and EI of more than 20% prove a non-organic origin? In the case of strength values with the break test within normal limits it probably rules out neuromuscular disease, but a central motor disorder is still possible. However, in the absence of central motor signs, as judged by an experienced neurologist, it supports a diagnosis of functional weakness on the basis of our results. A problem arises in the case of a high BI and EI with subnormal values in the break test. An organic disorder (with superimposed functional weakness) cannot be excluded. It is well known that some of the neurological patients with hysteria have an organic disease.[1,2]

In our fourth group of patients, measured without previous knowledge, there was agreement with the established diagnosis in 19 out of 20 cases, based on the criteria of BI and/or EI >20% indicating functional weakness. One patient had multiple sclerosis and fulfilled these criteria. Although he had no spasticity or hyperreflexia and normal strength with the break test, he definitely had an organic disease. This does not necessarily mean this patient had no functional weakness. As stated before, the combination of functional weakness and organic disease is not rare. Two other patients of this group had an organic neurological disease. Their paresis was nevertheless considered functional by a team of neurologists. Since there is no gold standard for functional weakness, it is difficult to judge the test results in terms of specificity and sensitivity.

Only a few tests to obtain a positive indication of functional weakness have been described. McComas *et al*[11] used the superimposed twitch on the recording of voluntary torque for foot dorsiflexors and plantarflexors, but according to the authors this test could be applied to almost any muscle with an accessible nerve supply. Most movements, however, are produced by a muscle group and not by a single muscle. Stokes *et al*[12] used stimulated twitches of the quadriceps superimposed on voluntary contraction in patients with effort syndromes. Gilbert and Knowlton[13] described a grip strength test in which they could determine "sincerity" of effort during a maximal isometric test of grip strength in cooperative normal and faking patients. It is questionable whether fakers are comparable with patients with functional weakness.

The make/break test appears to be a useful addition to these tests and has the advantage of being a simple extension of hand-held dynamometry[14] and of being relatively comparable to the routine clinical strength examination.

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