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A motor function measure scale for neuromuscular diseases. Construction and validation study

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Abstract

A new scale for motor function measurement has been developed for neuromuscular diseases. The validation study included 303 patients, aged 6–62 years. Seventy-two patients had Duchenne muscular dystrophy, 32 Becker muscular dystrophy, 30 limb-girdle muscular dystrophy, 39 facio-scapulo-humeral dystrophy, 29 myotonic dystrophy, 21 congenital myopathy, 10 congenital muscular dystrophy, 35 spinal muscular atrophy and 35 hereditary neuropathy. The scale comprised 32 items, in three dimensions: standing position and transfers, axial and proximal motor function, distal motor function. Agreement coefficients for inter-rater reliability were excellent ($\kappa = 0.81$–0.94) for nine items, good ($\kappa = 0.61$–0.80) for 20 items and moderate ($\kappa = 0.51$–0.60) for three items. High correlations were found between the total score and other scores: Vignos ($r = 0.91$) and Brooke ($r = 0.85$) grades, Functional Independence Measure ($r = 0.91$), the global severity of disability evaluated with visual analog scales by physicians ($r = 0.88$) and physiotherapists ($r = 0.91$). This scale is reliable, does not require any special equipment and is well-accepted by patients. Its sensitivity to change is being assessed to permit its use in clinical trials of neuromuscular diseases.

Keywords: Neuromuscular disease; Motor function; Metrology; Scale; Validation; Clinical trials

1. Introduction

In neuromuscular diseases, identification of new genotypes and hope for gene therapy have obliged scientists and clinicians to collaborate in order to classify phenotypes more precisely and to link them to specific genetic defects. Evaluation of motor deficit, and in particular measurement of muscle force by muscle testing or instrumental measures, is the most frequently used evaluation [1,2]. However, this muscle testing does not reflect the subject's functional abilities. These depend on the heterogeneity of the muscle defect, the muscular compensations and the limitations of the joints.

Several tests for the measurement of motor function have been proposed: the Functional Motor Scale for spinal muscular atrophy (SMA) [3]; the ALS score [4], the Tufts Quantitative Neuromuscular Exam [5] and the Amyotrophic Lateral Sclerosis Functional Rating Scale [6] for amyotrophic lateral sclerosis; the Hughes Functional Score [7] for Guillain-Barre syndrome and the Hammersmith Motor Ability Score [8] for Duchenne muscular dystrophy (DMD). Some tests focus on the function of one part of the body: the Zupan Functional Test [9] or the Brooke Upper Extremity Scale [1] for the upper limbs and the Vignos Lower Extremity Scale for the lower limbs [10]; other tests specifically address a single medical question such as the Diagnostic Motor Performance Test [11] for establishing the differential diagnosis between myopathy and neuropathy. Some have not been validated: Timed tasks [1] and others are non-specific such as the Jebsen Hand Function Test [12], or have not been adapted or validated for neuromuscular diseases, like the Gross Motor Function Measure which has been validated for cerebral palsy [13]. At the moment, there is no well validated test which is easy to administer and which has been adapted for the objective

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evaluation of motor function in the most frequent neuromuscular diseases [14].

In this paper, we describe the results of a validation study of the Motor Function Measure (MFM), a new scale to assess severity and disease progression of neuromuscular diseases. This scale is designed for use by physiotherapists or rehabilitation physicians in their daily clinical practice. It could also be useful for clinical trials.

2. Material and methods

The study was approved by the Medical Ethical Committee of the Academic Medical Center Lyon A (France) and the Ethics Committee of Lausanne University (Switzerland). Adult patients and parents of affected children gave written informed consent prior to evaluation. Children were personally asked to sign a consent form.

2.1. Construction of the scale

2.1.1. Initial version

Physical therapists, occupational therapists and rehabilitation physicians who had experience in the management of patients with neuromuscular diseases participated in the creation of the scale. Initially 75 scale items were selected based on (i) various published motor function scales, mainly the Gross Motor Function Measure, (ii) the experience of the investigators and (iii) a pilot testing with patients and parents. The development of the MFM scale began in 1998, with items written in French and translated in English. This draft initial version was sent with a demonstration video to 115 groups in Europe and North America. Forty-seven groups provided expertise concerning the selection of the diseases to which the scale could be appropriate, the age groups of patients and in the selection and scoring of the items. Based on criticisms and suggestions, the MFM study group created a first version including 51 items. Each item was rated on a 5-point scale (0/No movement—4/Completely normal movement).

2.1.2. First validation study

The French 51-item version was evaluated between May 2000 and March 2001 in 16 centers in France and one center in Switzerland. The participating centers included hospital groups, physical therapy centers, motor handicap centers, and a residential facility for handicapped people. Three-hundred and seventy-six patients with a suspected or confirmed diagnosis of neuromuscular disease, excluding myasthenia and myositis, aged 6–60 years, were tested by 18 trained physiotherapists [15]. Analyses of reliability, factor analysis, convergent and discriminant validity analyses were performed. The items relating to the assessment of the face had a poor reliability, other items were closely correlated, and some items had a poor feasibility. Therefore, a reduced version was developed. Three clinically significant dimensions were identified: standing position and transfers, axial and limb proximal motor function and limb distal motor function, which were the basis for the construction of the second version.

2.1.3. Final version

The second and final version consists of 32 items tested in lying, sitting and standing positions. The items are listed in Table 1. The scoring uses a 4-point Likert scale based on the subject's maximal abilities without any assistance. The generic grading is: 0, does not initiate movement or starting position cannot be maintained; 1, partially completes the exercise; 2, completes the exercise with compensations, slowness or obvious clumsiness; 3, completes the exercise with a standard pattern. The total score ranges from 0 to 96 when summing the 32 items. To enable comparison with other scores, the result is expressed as a percentage of the maximum possible score. To facilitate interpretation of the performances and grading of each item, only two components of a function have to be taken into consideration; for example, for scoring one item the examiner must consider the amplitude of a movement and the endurance, and for scoring an other item, the position of a joint and the transition from one position to another. The grading does not take into consideration whether the reason for being unable or partially unable to perform one item has a muscular origin (weakness), a tendinous origin (contracture), or is due to pain. The starting position does not systematically penalize the patients with passive limitations of joints.

The scale requires standard equipment available in any physiotherapy room. How to complete each exercise and how to precisely score each item is detailed in a manual of guidelines (an example is given in Fig. 1). Considering the importance of the environment for performing certain items, the material to be used is described very precisely in the manual, e.g. the height of the chair to assess the ability to stand up is specified. Precisions concerning the possible use of technical aids and ortheses are given. The physiotherapist also reports the level of cooperation (nul, moderate, optimal) and the fatigability during the scale (yes/no). The user's manual is available at www.afm-france.org.

2.2. Participating centers and investigators' training

The 19 centers which participated in this study were those who tested the first version, plus two centers in France. Before the study, 22 physiotherapists were trained in a one-day training session with videos of several patients with various degrees of disability. At the end of the training day, a video tape was prepared to verify that all therapists reached the expected level of reliability. At least two patients had to be tested as a practice exercise within each center before using the MFM scale for the study.

Table 1
List of the 32 items of the Motor Function Measure with the starting position and exercises required

No.	Starting position	Exercise required and conditions for obtaining maximum score
1	Supine	Head in the axis: maintains the head in the axis and turns it completely to one side and then to the other
2		Raises the head and maintains the raised position
3		Flexes the hip and the knee more than 90 degrees by raising the foot from the mat
4		Lower limb supported by examiner: from the position in plantar flexion, raises the foot in dorsal flexion of 90 degrees in relation to the leg
5		Raises one hand from the mat and moves it to the opposite shoulder
6		Lower limbs half-flexed, patella facing up and feet resting on the mat: raises the pelvis, lumbar spine, pelvis and thighs aligned and feet slightly apart
7		Rolls to prone and frees the upper limbs
8		Without support of upper limbs, sits up on the mat
9	Seated on the mat	Without support of upper limbs, maintains the sitting position and is then capable of maintaining contact between the two hands
10		The tennis ball placed in front of the subject: without support of upper limbs, leans forward, touches the ball and sits up again
11		Without support of upper limbs, stands up
12	Standing	Without support of upper limbs, sits down on the chair, feet slightly apart
13	Seated on the chair	Without support of upper limbs or leaning against the back of the chair, maintains the sitting position, head and trunk in the axis
14	Seated on the chair or in their wheelchair	Head in flexion: from the fully flexed position, raises the head and maintains the raised position, head in the axis during the movement and when maintained
15		Forearms on the table but not elbows: raises both hands to the top of the head at the same time, head and trunk in the axis
16		The pencil on the table: reaches the pencil with one hand, elbow in complete extension at the end of the movement
17		10 coins placed on the table: successively picks up and holds 10 coins in one hand within 20 s
18		One finger placed in the center of the fixed CD: traces the complete border of the disk with one finger without support of the hand
19		The pencil on the table: picks up the pencil placed next to their hand and draws a continuous series of loops of 1 cm height in the 4-cm-long frame
20		Holding the sheet of paper: tears the paper folded in 4, beginning at the fold
21		The tennis ball on the table: picks up the ball, raises it off the table and turns over the hand holding onto the ball
22		A finger placed in the center of the fixed square: raises the finger and places it successively in the center of the 8 squares of the diagram without touching the lines
23		Upper limbs along the trunk: places the two forearms and/or hands on the table at the same time
24	Seated on the chair	Without support of upper limbs, stands up, feet slightly apart
25	Standing with support of upper limbs on equipment	Lets go of the support and maintains the standing position, feet slightly apart, head, trunk and limbs in the axis
26		Without support of upper limbs, raises one foot for 10 s
27	Standing	Without support, lowers theirself, touches the floor with one hand and stands up again
28	Standing without support	Walks forward 10 steps on both heels
29		Walks forward 10 steps on a straight line
30		Runs 10 m
31		On one foot: hops 10 times in place on one foot
32		Without support of upper limbs, attains the squatting position and gets up twice in a row

2.3. Patients

All the eligible children and adults, with any degree of severity, aged from 6 to 60 years had to be recruited consecutively in outpatient or inpatient units between May 2002 and March 2003. Some of the patients could have participated in the first version study evaluation. Patients had to belong to one of eight pathology groups: (1) Duchenne muscular dystrophy, (2) Becker's muscular dystrophy (BMD), (3) facio-scapulo-humeral dystrophy (FSHD), (4) limb girdle muscular dystrophy (LGMD), (5) myotonic dystrophy (MD), (6) spinal muscular atrophy, (7) congenital myopathy (CM) and congenital muscular dystrophy (CMD) and (8) hereditary neuropathy (HN). The diagnosis had to be confirmed by a genetic analysis or a muscle biopsy. Patients with recent surgery or understanding problems were excluded. At least 30 patients were required in each group to ensure a good representativeness of the main neuromuscular diseases. Congenital myopathy and congenital muscular dystrophy were combined, because of their low frequency in neuromuscular clinics. The age range from 6 to 60 years was chosen in order to avoid taking into consideration the motor development of the young child and the motor limitations due to ageing.

Questions about social life, mobility, respiratory assistance and technical aids were asked.

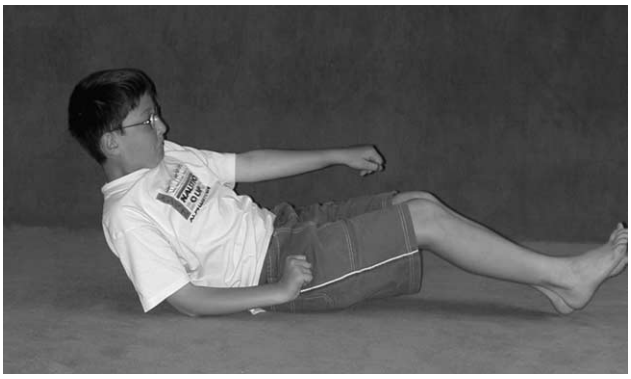

Fig. 1. Scoring of the item number 8. Supine: without support of upper limbs, sits up on the mat. *Position the subject on the mat or a wide table, arms and legs comfortably positioned. Legs extending beyond the edge of the table are not allowed. *Instruct the patient to sit up, arms free if possible. Once the sitting position is achieved, the arms can be used to gain stability. 0, does not initiate movement; 1, initiates movement or sits up on the mat by rolling to prone; 2, sits up on the mat by arm propping-rolling onto one side is permissible, as well as propping with one or both arms but not rolling to prone; 3, without support of upper limbs, sits up on the mat.

2.4. Design and clinical evaluations

The psychometric properties of the scale were assessed according to the recommendations of the American Psychological Association [16]. Inter and intra-observer (test– retest) reliability was tested with sub-samples of 50 patients. Five centers participated in the inter-observer study and 11 in the intra-observer study. In both cases, the second testing took place 15–30 days after the first, with the assumption that the patients' motor disability remained unchanged in this period of time. The construct validity was assessed by factorial analysis for evaluation of internal structure and the underlying dimensions and correlation for convergent validity [17]. The three dimensions identified as valid in the first version were: (1) standing position and transfers (2) axial and proximal limb motor function and (3) distal limb motor function. Correlations for convergent validity included criteria such as Brooke and Vignos grades, the Functional Independence Measure (FIM), four visual analog scales (VAS) of severity of disability as assessed by physicians and physiotherapists globally and per dimension and one VAS by patients and parents (when patients were children). The VAS was a 10 cm scale and a line had to be drawn between 0, no deficiency and 10, extremely severe deficiency. Internal consistency of the MFM scale was assessed based on the global scale and the underlying dimensions. Discriminant validity was assessed by comparing total scores of the scale according to severity grading (Clinical Global Impression of the physician on a 4-point scale which classifies the motor disability as mild, moderate, severe or very severe), and diagnosis group. After the completion of the scale the physiotherapists had to evaluate the cooperation of the subject as null, moderate or optimal. They had also to indicate if fatigue had appeared during the testing as a dichotomic variable (yes/no).

2.5. Statistical methods

Continuous variables are described as mean, SD and range, and categorical data are reported as frequency and percentage. The distributions of individual item scoring were checked.

A principal component analysis was performed, using Kaiser's criterion (eigenvalue >1), followed by a varimax rotation to obtain independent dimensions. The corresponding subscores were calculated by summing the items within each dimension.

Inter- and intra-rater reliability of each item of the scale was assessed through Cohen's kappa agreement coefficient and that of total and subscores (derived from factor analysis) through Fisher's intraclass correlation coefficient (ICC) computed with a random effect Anova model. These coefficients could be interpreted [18] as poor (<0.4), moderate (0.4–0.6), good (0.6–0.8) and excellent (>0.8). A coefficient greater or equal to 0.50 was considered acceptable for all reliability coefficients.

The internal consistency of the overall scale and subscales was measured by Cronbach's alpha coefficient.

Pearson or Spearman rank correlation coefficients were calculated to assess the convergent validity.

For discriminant validity, comparisons between groups were made using Anova followed by t tests for pairwise comparisons in case of significance.

The P values for significance were set at 5% level. Statistical analysis was done using BMDP software [19].

3. Results

3.1. Population studied

Three hundred and three patients were evaluated. Their mean age was 24.5 years $\pm$ 15.4 (6–62 years). Two patients aged 61 and 62 remained in the study. Forty-nine percent were children under 18 years of age. The sex ratio M/F was 69/31, due to a large group of DMD and BMD patients. Eighty-two percent lived at home and 18% in permanent or week care facilities. Thirty-nine percent of the adults had a professional activity. Forty-five percent were not able to walk and 57% used a wheelchair. Seventeen percent had intermittent (13%) or permanent (4%) respiratory assistance and 6% had a tracheotomy. Seventeen percent were rated as mild disability, 29% moderate, 38% severe and 16% very severe by the physician on their Global Clinical Impression scale. The diagnoses and the severity evaluated by the Clinical Global Impression of the physician are presented in Table 2. Progressive muscular dystrophies represent 66% of the total.

3.2. Face validity and scale completion

Therapists estimated that the items of the scale assessed severity of motor disability correctly and thoroughly.

Table 2
Distribution of patients in relation of severity of the motor deficit in the four categories (1, mild; 2, moderate; 3, severe; 4, very severe) evaluated by physicians (clinical global impression) in each diagnostic group

Severity	1	2	3	4	Total
Diagnosis	%	%	%	%	*n*
DMD	0	13.9	54.2	31.9	72
FSHD	15.4	53.8	30.8	0	39
HN	62.9	31.4	5.7	0	35
SMA	2.9	14.3	54.3	28.6	35
BMD	21.9	43.8	21.9	12.5	32
LGMD	10.0	3.3	76.7	10	30
MD	41.4	41.4	17.2	0	29
CM	9.5	52.4	23.8	14.3	21
CMD	0	20.0	30.0	50.0	10
Total (%)	17.5	28.7	38.0	15.8	(*n*=303)100%

DMD, Duchenne Muscular Dystrophy; FSHD, Facio-Scapulo-Humeral Dystrophy; HN, Hereditary Neuropathy; SMA, Spinal Muscular Atrophy; BMD, Becker Muscular Dystrophy; LGMD, Limb Girdle Muscular Dystrophy; MD, Myotonic Dystrophy; CM, Congenital Myopathy; CMD, Congenital Muscular Dystrophy.

The physiotherapists found the scale easy to administer. It took an average of 36 min (range 8–75 min) to complete the scale (Fig. 2). The time required depended on the number of items to be assessed, on the subject's comprehension of the task and on the difficulty to get the subject into the right position. When the standing position was impossible, only 21 items had to be performed. No relation was found between the severity of disability as evaluated by the physician and the time required to complete the scale. Cooperation of the patients was recorded as optimal in 91% of cases and moderate in 9%. According to the physiotherapists, 18% of patients showed a fatigability, which was not related to the duration of the scale. A total of 15% of patients discovered functional possibilities that they were not aware of.

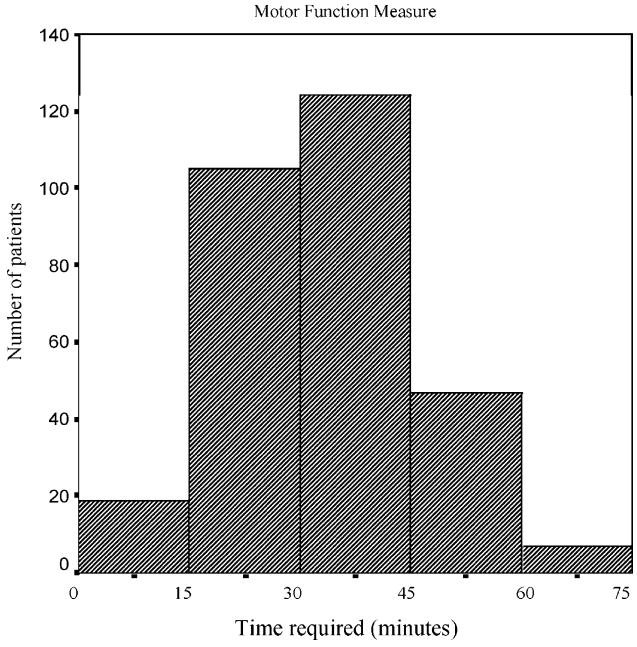

Fig. 2. Number of patients in each time interval needed to complete the Motor Function Measure.

3.3. Factor analysis

The three dimensions of the scale identified with the first version were confirmed after factor analysis (Table 3) and accounted for 75% of the variance: the first factor D1 (32%) contained 13 items and were those tested in the *standing position* and using *transfers*; the second factor D2 (26%) consisted of 12 items, representing *axial and proximal limb motor function*; the last factor D3 (17%) contained the seven items of *distal motor function*.

3.4. Reliability

The inter-rater reliability, Cohen's kappa coefficients ranged from 0.81 to 0.94 (excellent) for nine items, from

Table 3
Rotated factor loadings of items of the Motor Function Measure scale (values <0.40 are not presented) and Cronbach's alpha coefficients for internal consistency of the three dimensions

Item	D1	D2	D3
1		0.65	
2		0.44	
3		0.69	
4			0.45
5		0.75	
6	0.70		
7		0.76	
8	0.68		
9		0.72	
10		0.73	
11	0.86		
12	0.79		
13		0.57	
14		0.56	
15		0.72	
16		0.66	
17			0.73
18			0.71
19			0.81
20			0.66
21			0.63
22			0.81
23		0.71	
24	0.83		
25	0.67		
26	0.79		
27	0.85		
28	0.83		
29	0.79		
30	0.89		
31	0.90		
32	0.87		
Cronbach' α	0.98	0.96	0.89

D1, standing position and transfers accounts for 32% of variance; D2, axial and proximal motor function accounts for 26% of variance; D3, distal motor function accounts for 17% of variance.

Table 4
Spearman rank correlation coefficients between the degree of disability evaluated with a Visual Analogic Scale (VAS) by physicians and physiotherapists, Vignos grade, Brooke grade and Functional Independence Measure (FIM) and total and dimensional scores of the Motor Function Measure (MFM)

	VAS physician	VAS physiotherapist	Vignos grade	Brooke grade	FIM
MFM total score	0.88	0.91	0.91	0.85	0.91
Score DI	0.90	0.94	0.93	0.73	0.87
Score D2	0.80	0.87	0.79	0.87	0.84
Score D3	0.64	0.70	0.56	0.65	0.64

D1, standing position and transfers; D2, axial and proximal motor function; D3, distal motor function.

0.61 to 0.80 (good) for 20 items and from 0.51 to 0.60 (moderate) for only three items.

Agreement coefficients for intra-rater test–retest were excellent ($\kappa = 0.81$–0.94) for 25 items, and good ($\kappa = 0.61$–0.80) for seven items.

The intra- and inter-rater agreement coefficients (ICC) were all excellent (0.96–0.99) for the total score and for the three dimensional sub-scores.

3.5. Internal consistency

The internal consistency was high for the global scale (Cronbach's alpha coefficient 0.99) and for the three dimensions subscales (Table 3).

3.6. Convergent validity

The severity of the disability evaluated independently with VAS by physicians (before completion of the MFM scale) and by physiotherapists (after administrating the MFM scale) was highly correlated (0.80–0.94) with the total score and the two first dimensions subscores (D1 and D2) of the MFM scale, and to a lesser degree with the third dimension D3 (0.64 and 0.70) (Table 4). However, no correlation was found between the total MFM score and the self-rated VAS of the patients (0.05) and only a moderate correlation with the parents' evaluation (0.55).

The total score of the MFM was highly correlated (0.91) with the Vignos grade (which evaluates the standing position and lower limb function) and the FIM, and to a lesser degree (0.85) with the Brooke grade (which evaluates upper limb function). The first dimensional subscore (standing position and transfers) was as expected to be highly correlated with the Vignos grade. The second subscore (axial and proximal limb motor function) showed the highest correlation with the Brooke grade, while the third subscore, distal motor function, showed a moderate correlation with any of the other scores (Table 4).

3.7. Discriminant validity

As shown in Table 4, the total score was strongly related to the severity of disability as assessed by physicians and physiotherapists (VAS). Mean scores significantly decreased with degree of motor disability as evaluated by the Clinical Global Impression of physicians (Fig. 3) (Anova $F^{3.299} = 293.2$, $P < 0.0001$—all means significantly different in pairwise comparisons).

To represent the different scores on the same scale and allow comparison across diagnoses (Fig. 4), the scores are expressed as percentage of the maximum score possible (example 39 for subscore D1). The total score and subscores allowed a good discrimination between diagnosis groups (Anova $F^{7.295} = 29.1$, $P < 0.0001$) (Fig. 4). As expected, DMD patients were the most affected on all scores, close to the SMA group. Those with the higher scores, i.e. less affected, were the FSHD, MD and HN groups, and in between were BMD, CM or CMD and LGMD. Interestingly, the third dimensional score showed a good level of distal motor function even for the most severely affected patients such as those with DMD and SMA.

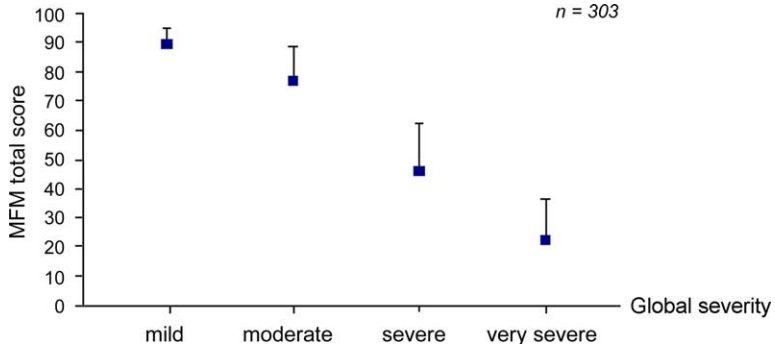

Fig. 3. Mean total scores (±SD) of the Motor Function Measure (MFM) according to four grades of global severity of motor disability as evaluated by physicians (Clinical Global Impression).

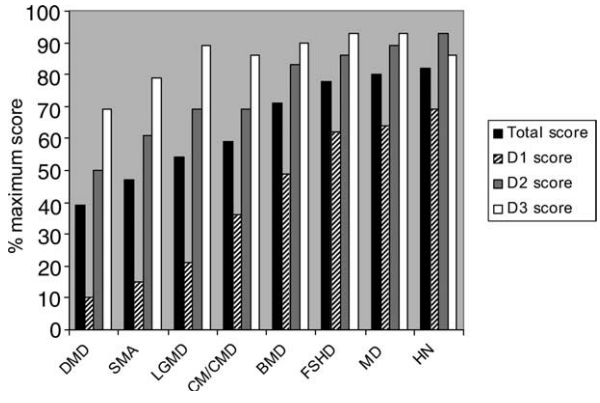

Fig. 4. Total and dimensional scores expressed as percent of maximal possible score according to diagnosis. D1, standing and transfers; D2, axial and proximal limb motor function; D3, distal limb motor function. DMD, Duchenne Muscular Dystrophy; SMA, Spinal Muscular Atrophy; LGMD, limb girdle muscular dystrophy; CM, Congenital Myopathy; CMD, Congenital Muscular Dystrophy; BMD, Becker Muscular Dystrophy; FSHD, Facio-Scapulo-Humeral Dystrophy; MD, Myotonic Dystrophy; HN, Hereditary Neuropathy.

4. Discussion

The MFM scale assesses the severity of the motor deficit in the main neuromuscular diseases, with good psychometric properties, for patients between 6 and 62 years of age. The score is reproducible, the coefficients of the inter-rater reliability are good or excellent for 29 items. The total score provided a good measure of the overall severity. There was a good correlation between the MFM scores and the evaluations of the severity of the disability by the physical therapist or the physician using VAS, and also the Brooke and Vignos grades of disability.

This measurement, unlike other existing scales, is adapted to all degrees of severity, for walking and non-walking patients; it evaluates the head, the trunk, upper and lower limbs. The scale is precise and detailed which the Vignos and Brooke grades are not. The detailed scoring exhibits a good reliability, which was not studied for the Hammersmith motor ability scale. The scale also allows an assessment of distal motor function, which is not available with the usual instruments for neuromuscular diseases. The evaluation of distal motor function is valuable for severe diseases such as DMD or SMA, where this function can be maintained over the long term compared to standing position and proximal limb motor function. The MFM scale has been validated and is specific for neuromuscular diseases unlike the Gross Motor Function Measure. The MFM scale evaluates motor function without reference to the environment and daily activities and is therefore complementary to the FIM and other scales which quantify the autonomy.

We found no correlation in our study between the global MFM score and the self-rated evaluation of motor disability. To the question, 'How are you hampered in your everyday activities ?', the patient (adult or child) probably responded more in terms of quality of life, which could not be verified, because there was no quality of life scale in our protocol. Other authors have established that disability is not a critical factor that significantly alters life satisfaction [20]. Patients tended to score their disability less severely than physicians or physiotherapists.

Other authors have pointed out the usefulness of a test of motor function in neuromuscular diseases as a complement or even as principal criterion compared to other evaluations of the muscle such as quantitative measures of muscle force, functional timed tests, or scales of independence in daily life or quality of life. For Iannacone [3], the muscle force might be stable when the motor function is degenerating and the use of the Gross Motor Function Measure was more clinically relevant than the Quantitative Muscle Testing in clinical trials in pediatric spinal muscular atrophy. In the EK-scale, Steffensen [21] combined evaluations involving deficiency, motor disability and autonomy in everyday life to assess the severity in non-ambulatory patients with DMD and SMA, and to predict the need for assisted ventilation in patients with DMD.

The scale was well-accepted by patients who apreciated the 'playful' aspect of some items. The time necessary to complete the scale took 15–45 min in 75% of cases. The physiotherapists appreciated the detailed testing manual and the previous training with a video to ensure a good reliability. It could be easily performed in an outpatient setting, with a standard commonly used equipment. Patients sometimes discovered functional possibilities or movements that they were unaware of, opening up perspectives for physical therapy or compensation by adaptation of apparatus.

This validation study has established the good validity and reliability of the MFM scale. A 1 year follow-up is ongoing, to study its sensitivity to change with a random subsample of 152 patients. The results will be submitted in a further publication. A repeated evaluation of motor capacities allowed by this scale is likely to allow to follow the spontaneous progression of the diseases. It also might predict essential clinical stages such as the loss of the ability to walk in progressive muscular dystrophies. The scale might also be used in controlled studies to quantify the result of therapeutic interventions such as surgery, braces, technical aids, physical therapy or drugs as a complement to manual muscle testing, a daily activities scale and a quality of life test.

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