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Original article

PROCEDURES FOR APPARATUS MUSCLE TESTING - ESSENCE AND PERFORMANCE

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ABSTRACT

The Muscle Test is an important tool for all healthcare team members who are committed to restoring the patient's physical health and a fundamental element in identifying motor disorders. The outcomes obtained from this test are the basis for choosing an optimal therapeutic approach, a strategy for rehabilitation and tracking of the recovery process in dynamics. The lack of objectivity and quantitative data for comparison in muscle strength measurement in manual testing creates prerequisites for inaccuracies and subjective judgment on the part of the examiner. This has given rise to the search for additional tools to support standard muscle assessment methods, such as apparatus muscle testing. It provides more accurate, quantitative and objective assessments and creates a prerequisite for refining the muscle test and preserving it in an electronic database accessible to a team of specialists.

Keywords: apparatus muscle testing, electronic database, physiotherapy

INTRODUCTION

Observations, studies, and research on functional methods for assessing muscular dysfunction in a number of diseases of the locomotor system and the nervous system have revealed a major problem in modern practice, namely the lack of objectivity and quantitative data for comparison in testing measurement) of muscle strength / weakness [1].

The Muscle Test is an important tool for all health team members involved in restoring the patient's physical health [2].

This diagnostic method is a fundamental element for identifying motor disorders and is the basis for determining the need for treatment, choosing an optimal therapeutic approach, rehabilitation strategy, and tracking the recovery process n dynamics [3].

The main inaccuracies in manual muscle testing were expressed in the difficulty of distinguishing the differences in muscle strength assessment for grades 4 and 5. These values depend on the subjective judgment of the examiner [4].

Their variations beyond what is considered to be a norm are in fact of great importance for the clinical practice and the direction of rehabilitation in the rehabilitation plan. In recent years, based on our research in this field and literature, we have come to the conclusion that standard muscle testing practiced in our country cannot provide a quantitative but only qualitative difference to the strength of "normal" muscles, and provides variegated and subjective information that depends on the learner's experience, experience and experience. This gives reason to search for additional tools to support standard methods for manual assessment of muscle strength. For this purpose, we have applied the most commonly used tools in the world practice - mobile device models for objectification and assessment of muscle strength. Although some authors are critical of innovation in this area, there is evidence that our research confirms that physical muscle testing gives more accurate, quantitative and objective assessments and creates a prerequisite for refining the muscle test and keeping it in an electronic database, accessible to a team of specialists [5].

The study was conducted at the "Medica – Rousse" University Hospital for Active Treatment. Patient consensus has been informed and necessary agreements have been made with the research base. Patients are randomly assigned.

The used dynamometer was Lafayette (Lafayette Instrument Company). Lafayette MMT is an ergonomic device for objective quantitative measurement of muscle strength. The test was performed with a clinically applied force to the patient's limb. The goal of the test was for the therapist to overcome (or "break") the patient's resistance [6].

The apparatus recorded the peak power and the time needed to achieve "refraction" by providing a reliable, accurate and stable way to measure muscle strength.

Interactive menus allowed a wide range of options: data storage, pre-set test times and applied force. The camera provides us with a wide range of features and features, and its size is small enough to fit comfortably into the palm of the examiner, providing the convenience of both the patient and the therapist [7]. This was a prerequisite for correct, easy and accurate execution of the protocol for muscle testing.

Measurement was performed with the same dynamometer on the first, third and seventh day of their stay on a clinical pathway in the health facility. To use the longest lever arm where the pressure on the skin will not cause pain, the dynamometer is placed distally on the test segment in a convenient location. To ensure that the dynamometer is placed in the same place during the test period, the corresponding area on the skin was marked [8].

The implementation of these objectives requires trained professionals, including physical therapists that provide complex and prolonged rehabilitation care [9].

The choice of the muscles we tested was dictated by the movement deficit due to the underlying disease. With the centimeter measure the distance from the bone growth that leans around the axis of movement of the segment to the point of application - center of the dynamometer head. The result is the length of the lever arm. At the same time, the patients were given a manual muscle testing routinely applied in our country as a tool for alternative muscle strength. The MMT was done by two examiners who measured, evaluated and recorded the data independently of each other and without announcing the values. Was this done in order to establish whether the assessment of the manual muscle test is objective and whether it is a good alternative to replace it with an in-vehicle muscular force test using an electronic dynamometer [10].

The basic rules were followed when performing the instrument test:

➢ Good knowledge of the standard procedure, position and stabilization. When modifications were required, they were further marked as "comments";

➢ The patient became familiar with the procedure and the instructions before the test was applied. The most valid method was chosen, in case of doubt, it was noted in a "comment" as a "note" (for example: difficulty understanding or cooperation, difficulty stabilizing, cramps, etc.);

➢ Evaluation (testing) was done at the same time so that fatigue did not affect the measurement. The same order of muscle testing was always observed, and the surface of the apparatus was perpendicular to the segment;

➢ It was necessary to assure that the subject has no contraindications (contraindications) to the test;

➢ The measurement position and object remained completely stable;

➢ In the assessment of one muscle group and a deviation of more than 10% in two consecutive measurements, a third test was re-performed;

➢ Relay link - The subject was encouraged using a voice tone that ranged from normal, progressively to high, and strong during the test period.

It was of particular importance to ensure that the patient starts a contraction of "come on" or "go" and stop when told to "release", that is, when the verbal communication for promotion is terminated.

The test sequence was performed on the 1st, 3rd and 7th day of the clinical pathway in the health facility in the same manner in the initial test session and was maintained in the same order. All of the strength tests were isometric, also known as make tests suitable for patients aged 20-79 according to Bohannon RW, (1986). The participants were stabilized with their hands by holding on to the sides of the table, the weight of the body or the investigator. Each test patient was positioned in a way to isolate the test movement (as much as possible), giving a greater mechanical advantage to the examiner (especially the knee joint extension and ankle movements that make the testosterone somewhat difficult).

RESEARCH SEQUENCE

Clinical work was conducted between January 2016 and June 2018. The study covered 47 patients with orthopedic and neurological diseases, aged between 42 and 87 years (average age 61.8 years). Each of them followed the therapist's instructions. The same patients were given standard manual muscle testing by two physiotherapists, independently of each other, and parallel hand-held testing with a portable electronic dynamometer. The patients who participated in the study had scores of over 3, basically 4 and 5 of the standard manual muscle assessment in rehabilitation wards.

Three values were recorded for each test muscle group. All dynamometric tests were performed by one clinician. The examiner manually stabilized the body in the proximal part of the test segment during the study. Prior to conducting the patient's test, the "movement" (isometric contraction) that he had to perform was shown. The second test of specific muscle groups was performed 30 seconds after the initial muscle.

During the procedure, the therapist kept the dynamometer turned from sight to remain "blind for evaluation" until the measurement was complete. After completion, the scale was counted and the results were recorded in the device. The direction of the dynamometer was always perpendicular to the segment targeted by the study. The apparatus was in the same place on the test segment [11].

The examiner applied resistance in a fixed position, the person was tested, giving 7 seconds maximum voluntary isometric contraction to the examiner's dynamometer. The dynamometer was located perpendicular to the test muscle group. Initially, the procedure was applied to the limb to establish a baseline and a rate of muscle strength for the patient.

After instructing the procedures, participants performed one isometric submaximal contraction in the investigator's hands to ensure that the correct test action was performed [12]. The individual test was applied three times. The highest value of the three consecutive measurements and their mean value was noted. The highest value was listed as "best." Between each test there was a 30 second rest period to avoid a drop in the strength of the tested muscles during the study due to fatigue. The standard command from the verifier was "press, press ... and release." The entire test session with a history, somatoscopy, anthropometry, protocol, and recording of the information lasted between 20-30 minutes per patient. The time for the muscle test itself is conditional and is determined by the number of muscles studied [13].

The evaluation itself was carried out after the test segment was placed in the most favorable position for the main muscles, eliminating as much as possible the auxiliary muscles. The investigator covered the dynamometer in his hand. The lower flat flange was located on the segment of the patient's limb, the changes in mechanical effort during the muscle testing process were recorded and recorded. During the initial phase, the test person put the limb on the dynamometer and in less than 3 seconds he put pressure on the investigator's hand, and the examiner resisted with a submaximal effort. During the next phase, the Examiner showed a supermaximal effort on the limb, where the mechanical force registration was displayed on the apparatus at the same time as the graph from which the dynamic force calculations result from the mechanical effort between the patient and the examiner. Submaximal effort is what does not exceed the possibilities of weak muscles, and the supramaximal is that which exceeds the strength of the weak muscles but does not exceed the strength of the strong muscles [14].

Fig. 1.1.

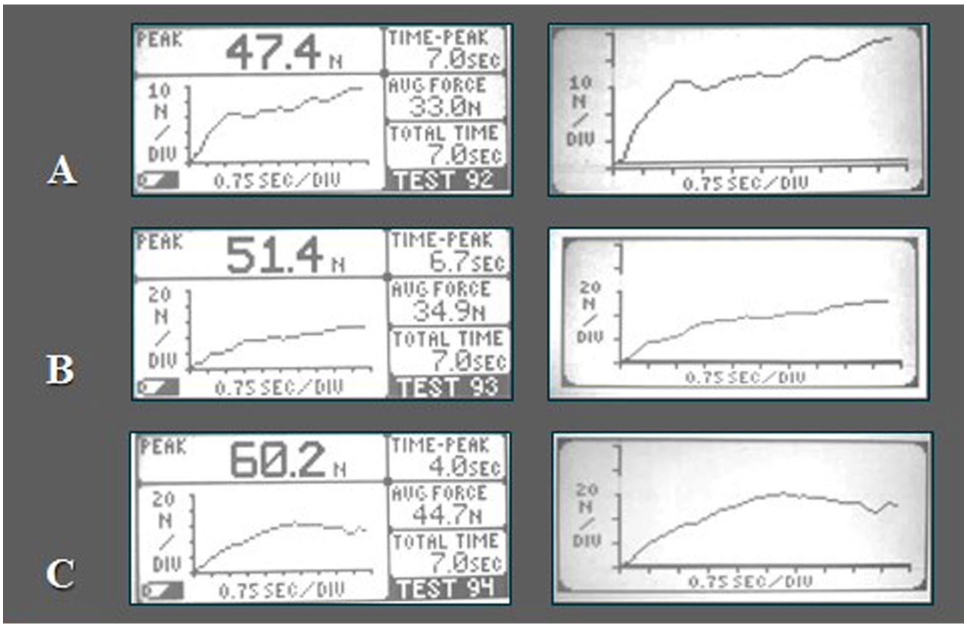

Fig. 1.2.

Patient initials	*Years old*	*Diagnosis (ICD)*	*Measurements with handheld dynamometer (HHD) Lafayette*			*№ of test with HHD*	*Manual muscle testing (MMT) first examiner*		*Manual muscle testing (MMT) second examiner*	
E. G.	55	*Compressio nervus medianus billateralis (sinistra)*	**Side**	**left (N)**	**right (N)**		**left**	**right**	**left**	**right**
Tested muscles: *m. deltoideus – pars acromialis; m. supraspinatus* ***Test movement:*** *abduction in the left shoulder joint* ***Point of placing of the HHD:*** *17 cm distal to acromion scapulae* ***Starting position:*** *lying on his back or sitting*			**First day**	47,4 N	x	92	5-	x	4+	5
			Third day	51,4 N	x	93	5-	x	4+	5
			Seventh day	60,2 N	x	94	5	x	4+	5

Difference in grades between the two reporting MMT_1 MMT_2	**Quantitative evaluation with HHD**	**It is appreciated by perception, subjectivism**		**Accuracy of measurement**		**Graphically logging changes**		**Data recording**		**Results from HHD show quantitatively direction of recovery**	**Results from HHD show quantitatively direction of recovery**	**Reported dynamic trend with HDD**	**Reported dynamic trend with MMT**	**Accessibility**	
		MMT	**HHD**	**MMT**	**HHD**	**MMT**	**HHD**	**MMT**	**HHD**					**MMT**	**HHD**
YES	**YES**	**YES**	**NO**	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**	**YES**	**YES**	**YES**	**NO**	**YES**	**YES**

The data presented on Figures 1.1. and 1.2. displays the estimates from the standard MMT were subjective when considering the different test subjects (4+ and 5 -) - there is a difference of one unit. The recovery process can not be noticed. The following objective results are observed in the instrument measurement: Figure (A) shows the patient's difficulty in exerting an effort on the movement under study. The line shows an oscillating process when the maximum effort is reached. After the treatment, as shown in graphs (B) and (C), there is resistance to isometric effort and increase in muscle strength, which speaks for a correct course of therapy.

Fig. 2.1.

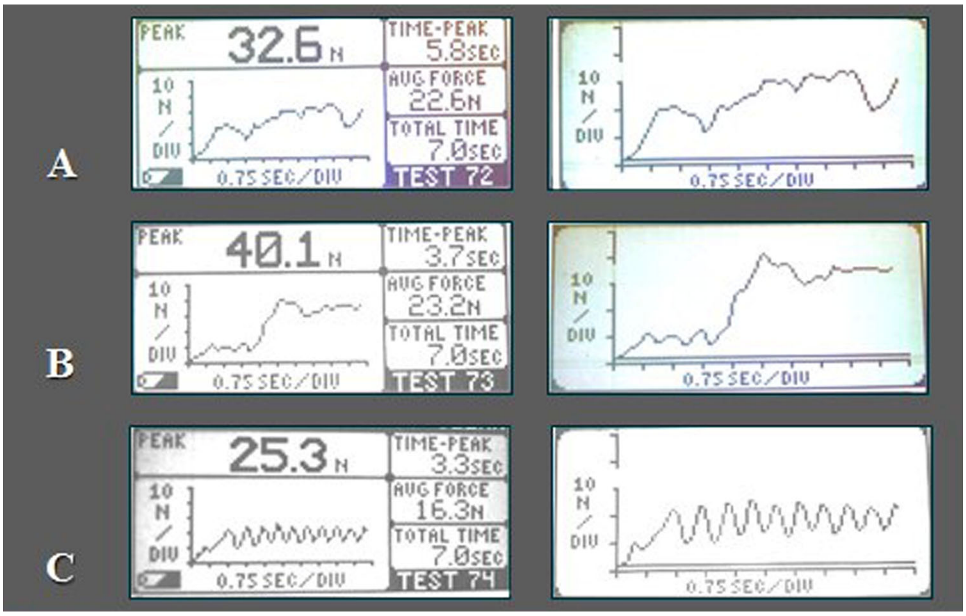

Fig. 2.2.

Patient initials	*Years old*	*Diagnosis (ICD)*		*Measurements with handheld dynamometer (HHD) Lafayette*		*№ of test with HHD*	*Manual muscle testing (MMT) first examiner*		*Manual muscle testing (MMT) second examiner*	
S. D.	80	*Status post fractura femoris dextra*	Side	left (N)	right (N)		left	right	left	right
Tested muscles: *m. semitendinosus, m. semimembranosus, m. biceps femoris*			First day	x	32,6	72	x	4	x	4-
Test movement: *flexion in right knee joint*			Third day	x	40,1	73	x	5-	x	4+
Point of placing of the HHD: *23 cm distal from the fossa poplitea* ***Starting position:*** *lying on his eyes or sitting*			Seventh day	x	25,3	74	x	4	x	4

Difference in grades between the two reporting MMT_1 MMT_2	Quantitative evaluation with HHD	It is appreciated by perception, subjectivism		Accuracy of measurement		Graphically logging changes		Data recording		Results from HHD show quantitatively direction of recovery	Results from HHD show quantitatively direction of recovery	Reported dynamic trend with HDD	Reported dynamic trend with MMT	Accessibility	
		MMT	HHD	MMT	HHD	MMT	HHD	MMT	HHD					MMT	HHD
YES	YES	YES	NO	NO	YES	NO	YES	NO	YES	YES	YES	YES	NO	YES	YES

The data presented on Figures 2.1. and 2.2. displays the striking example of how handpiece testing differs from the manual-muscle test and can also have diagnostic value. Measurements show sharp limits in muscle effort probably due to a neurological problem that is not reflected in the patient's cardboard. From the graphs of the instrument measurement, it is evident that there is another factor in the rehabilitation process, which hampers the recovery and that is the tremor. In the MMT assessment, this cannot be noted. Graphs show a highly unattractive, highly fluctuating process.

Fig. 3.1.

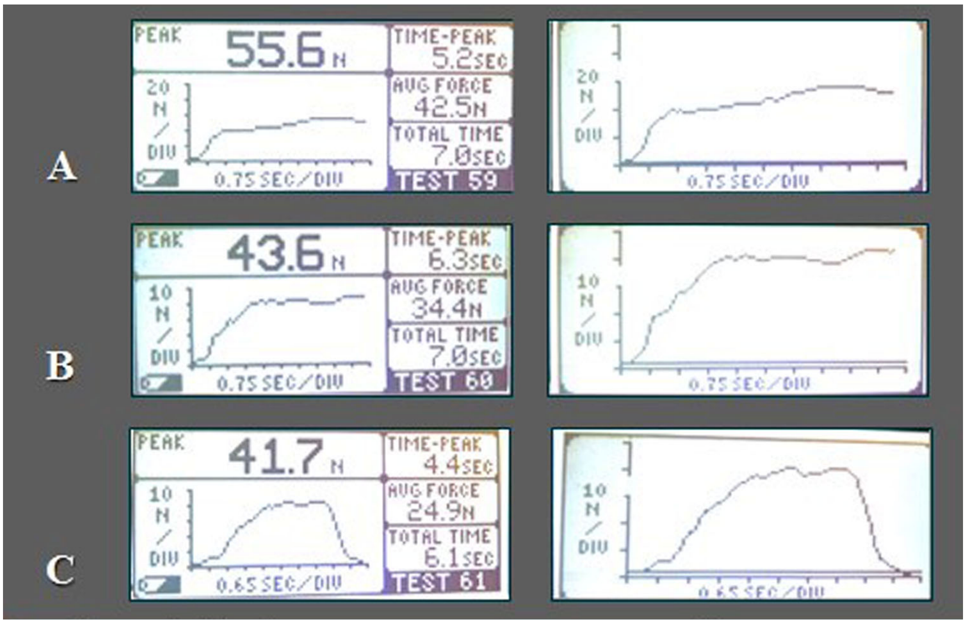

Fig. 3.2.

Patient initials	*Years old*	*Diagnosis (ICD)*		*Measurements with handheld dynamometer (HHD) Lafayette*		*№ of test with HHD*	*Manual muscle testing (MMT) first examiner*		*Manual muscle testing (MMT) second examiner*	
L. D.	84	*Alloplastica coxae sinistra, Coxarthrosis dextra*	Side	left (N)	right (N)		left	right	left	right
Tested muscles: *m. gluteus medius, gluteus minimus*			First day	x	55,6	59	x	4	x	4
Test movement: *abduction in right hip joint*; ***Point of placing of the HHD:*** *28 cm distal from trochanter major*			Third day	x	43,6	60	x	4	x	4
Starting position: *lying on his back*			Seventh day	x	41,7	61	x	4	x	4

Difference in grades between the two reporting MMT_1 MMT_2	Quantitative evaluation with HHD	It is appreciated by perception, subjectivism		Accuracy of measurement		Graphically logging changes		Data recording		Results from HHD show quantitatively direction of recovery	Results from HHD show quantitatively direction of recovery	Reported dynamic trend with HDD	Reported dynamic trend with MMT	Accessibility	
		MMT	HHD	MMT	HHD	MMT	HHD	MMT	HHD					MMT	HHD
NO	YES	YES	NO	NO	YES	NO	YES	NO	YES	YES	YES	YES	NO	YES	YES

The data presented on Figures 3.1. and 3.2. displays the absorption of coxae abnormalities in the two test subjects did not show differences in the manual muscle test scores. Estimations of MMT at the beginning and end of the hospital stay do not vary with the MMT. From the graphs in the instrument measurement, unlike the manual, it is noted that during the rehabilitation process there is no tendency to improve muscle strength and recovery, on the contrary - the graphs reflect a weakness in the musculature in the rehabilitation process. The figure and the graphs clearly show a patient worsening trend, most clearly reflected in the graph (C), where the patient not only did not reach the force he had applied in the previous measurement but was unable to hold it for a few seconds.

The position of the respective segment in the test was based on procedures commonly applied in clinical conditions.

For precise and accurate results during the muscle strength measurements performed on patient contingents, standard baseline baseline states were described by: Bîhannon [3, 4, 12], Eek M. N., Kroksmark A. K., Beckung E., [15], St. Bankov and others, [16].

For muscle weakness, this condition was assumed, with a total test time of less than 3 seconds, that is, the patient had no strength to develop prolonged effort, or the relative increase in maximum effort from the first to the second phase of the muscle test was -main the threshold parameters.

The maximum mechanical force values were determined by the force change graph recorded by the apparatus. If none of these conditions are met, normal muscle strength is found [6].

CONCLUSION

Muscle testing, as a measure of the functional state of the neuromuscular system, offers additional diagnostic parameters for clinical studies in the evaluation of patients with physical dysfunctions treated by general practitioners and specialists (orthopedists, traumatologists, neuroscientists), physiotherapists and others.

Applied muscle testing can improve clinical decision making and lead to better patient care by detecting change or lack of change in motor performance after manipulative treatment. This can be achieved by using portable electronic dynamometers (HHDs), which are increasingly convincing in the researcher's practice, to obtain objective, accurate and quantitative data on tested muscles.

The proposed method of determining muscle strength is that it provides increased reliability of the assessment and the results of the apparatus testing as opposed to manual, provides the opportunity to illustrate and document measurement data and maintain an individual database applicable to electronic health map.

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