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Original Article

MMT measurements are acceptable in routine clinical practice: Results from periodic medical examinations of polio survivors

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ABSTRACT
Sawada K, Saitoh E, Horii M, Imoto D, Itoh N, Mikami Y, Ikeda T, Ohashi S, Terauchi R, Fujiwara H, Kubo T. MMT measurements are acceptable in routine clinical practice: Results from periodic medical examinations of polio survivors. Jpn J Compr Rehabil Sci 2017; 8: 51−55.
Purpose: The aim of this study was to investigate whether manual muscle test (MMT) for the hip (abduction, flexion, and extension), knee (flexion and extension), and ankle (dorsal flexion) muscles are acceptable in routine clinical practice.
Methods: The study included 222 participants (487 examinations, 974 legs) of periodic medical examinations for polio survivors in the Tokai district of Japan. The subjects were 175 men (350 legs) and 312 women (624 legs) with an average age at the time of examination of 62.2 (32−82) and 61.6 (47−83) years, respectively. The results of handheld dynametric muscle test were compared for each MMT grade and joint motion.
Results: Significant differences in muscle strength were observed for the majority of pairs of MMT grades, excluding the MMT 0/1 pair. The specific combinations with no significant differences were MMT 1/2 for knee flexion (women); and MMT 0/2 (both men and women), 1/2 (both men and women), and 3/4 (men) for ankle dorsal flexion.
Conclusion: Clinical MMT measurements seem to be generally acceptable, at least when performed by physical therapists with 5 or more years of clinical experience. However, ankle dorsal flexion requires especially careful assessment.
Key words: manual muscle test, dynametric muscle test, polio, post-polio syndrome

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Introduction

Although manual muscle test (MMT) is used internationally and its clinical usefulness is generally recognized [1], susceptibility to tester bias has been suggested [2, 3]. Handheld dynametric muscle test (DMT) is regarded as a more objective method [2, 3] based on its high intra- and intertester reliability [1, 4]. Although DMT was successfully utilized for detecting chronological changes of muscle strength in former polio subjects with post-polio syndrome (PPS) [5], when used alone it is not suitable for detecting the existence and/or determining the extent of muscle strength impairment because of large individual variations even in healthy subjects [6, 7]. Hislop et al. pointed out the necessity of assessing the interrelation between MMT results and muscle force measurements obtained by using devices such as the handheld dynamometer [8].

Historically, MMT has been widely used to evaluate muscle weakening related to poliomyelitis [9, 10]. Although the introduction of the polio vaccine has prevented new-onset poliomyelitis cases, the pandemic outbreak of the disease that took place in

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Japan from the 1950s to the 1960s has created the problem of PPS among former polio patients. The most common symptoms include slowly progressing muscle weakness, fatigue (both generalized and muscular), and a gradual decrease in the size of muscles (muscle atrophy) [11]. Patients may suffer from asymmetric flaccid paralysis of variable severity and localization (upper or lower limbs, proximal or distal) regardless of the presence of previous symptoms. Although spasticity does not interfere with the testing, the lack of suitable control might make it difficult to assess muscle weakness with MMT, especially for grades 4 (good) and 5 (normal).

We provide a periodic medical examination as part of the comprehensive rehabilitation programs for polio survivors who mainly live in the Tokai district of Japan, which constitutes about 10% of Japan's total population. This periodic examination, which includes MMT and DMT, is undergone by a large number of patients with varying degrees of motion impairment in each affected joint. Since a number of examiners are involved in the testing and the examinations are to be carried out within a limited time, the testing environment can be considered very close to a clinical environment.

The purpose of this study was to investigate whether MMT for the hip (abduction, flexion, and extension), knee (flexion and extension), and ankle (plantar flexion) muscles are acceptable in routine clinical practice. Ankle plantar flexion was excluded from this study because the MMT grade was affected by the level of muscle endurance.

Methods

1. Subjects

The periodic medical examinations for polio survivors have been carried out every 4 months since June 2007. A total of 222 patients participated in this study. Among these patients, 69, 43, 108, and 2 individuals took the examination 1, 2, 3, and 4 times, respectively, resulting in 487 examinations (974 legs) performed between June 2007 and February 2014. Of these, 175 examinations were performed in men (350 legs) and 312 in women (624 legs). The interval between examinations for each individual was at least 2 years. The average age at the time of examination was 62.2 (32−82) years for men and 61.6 (47−83) years for women. Mean height and weight were 161.9 (143.0−176.9) cm and 64.1 (38.0−121.7) kg for men and 149.8 (129.7−166.6) cm and 50.8 (29.9−80.0) kg for women.

2. Strength assessments

Assessments were focused on the hip (flexion, extension, abduction), knee (flexion, extension), and ankle (dorsal flexion) muscles on both sides. Examinations were performed by physical therapists with at least 5 years of clinical experience. Several pairs consisting of an examiner and a recorder conducted the strength assessments at each periodic medical examination. Participants were randomly allocated to an examiner, who performed a series of MMT and DMT evaluations. Hip flexion was tested first, followed in order by hip flexion, hip extension, hip abduction, knee flexion, knee extension, and ankle dorsal flexion.

For each joint motion, the examiner performed MMT according to the published procedures [8], and the strength of each muscle was graded on a scale from 0 to 5. Next, DMT was performed twice for each joint motion using a handheld dynamometer (μTas F-1®, Anima Corp., Japan) as a quantitative muscle strength measurement. The approach of Bohannon was followed with respect to the subject positions and dynamometer placement [12]. Isometric forces (N) determined during the first and second measurements were recorded as F1 and F2, respectively. The greater of the two was defined as Fmax and the remaining one as Fmin.

The examiners were not given any information about the participants, such as the results of previous examinations or their clinical history throughout the assessment. Ethical approval was obtained from the ethics committee of Fujita Health University.

3. Data analysis

First, correlations (Pearson product-moment correlation coefficient) between F1 and F2 were investigated for each joint motion to evaluate if the DMT measurements were stable. The Fmax values grouped according to the corresponding MMT grades were then compared for each joint motion using one-way analysis of variance (one-way ANOVA) separately for men and women, with comparisons between individual groups conducted using the Student's *t*-test with Bonferroni correction. For the evaluation of ankle dorsal flexion, the joints with equinus contracture (dorsiflexion of $\leq -20°$) were excluded.

p values of <0.05 were considered to indicate a statistically significant difference. Statistical analyses were conducted with StatFlex Ver. 6.0 (Artech Co., Ltd., Osaka, Japan).

Results

1. Correlations between the first and second DMT measurements

The relationship between F1 and F2 for each joint motion is shown in Figure 1. Although all the correlations were statistically significant, the correlation coefficient was relatively low for ankle dorsal flexion ($r = 0.616$). For this motion, cases with Fmin of 0 N and Fmax of ≥50 N were present in 105 of the 307 joints (34.2%).

The F1/F2 average (N) was 74.5/73.8, 73.7/74.6,

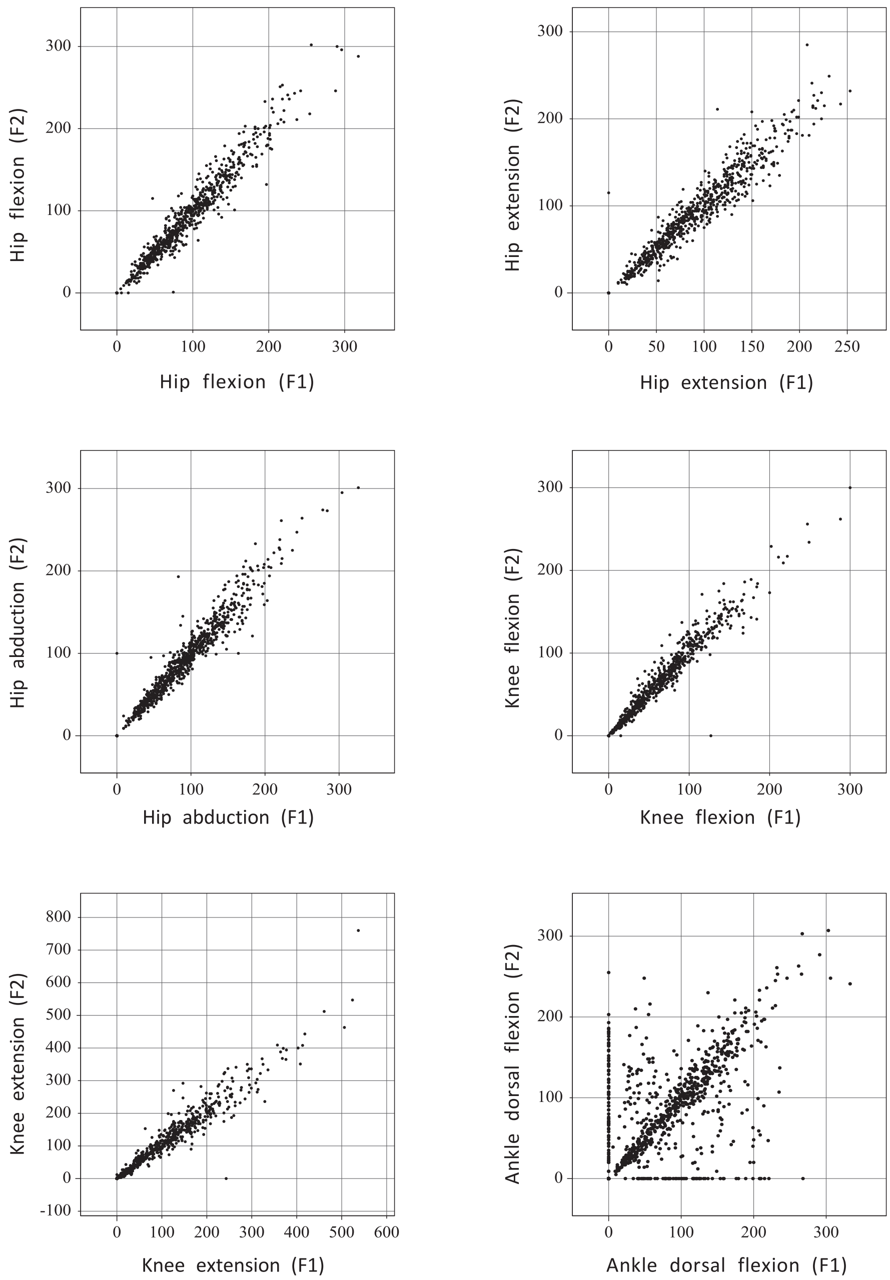

Figure 1. Correlations between F1 and F2 (N) for each joint motion.

79.5/79.9, 55.1/55.5, 85.6/87.4, and 71.9/71.6 for hip flexion, hip extension, hip abduction, knee flexion, knee extension, and ankle dorsal flexion, respectively. No statistically significant differences were detected between F1 and F2 for any of these joint motions.

2. Relationship between MMT grades and quantitative muscle strength measurements obtained with DMT

The averages values and SDs of Fmax according to joint motion and gender are shown in Table 1. The table also presents the number of joints for each MMT grade. One-way ANOVA revealed significant differences for every joint motion for both men and women (p = 0.0000). There were no significant differences between the groups with MMT grades 0 and 1 for any joint motion. Significant differences were observed for many other combinations of MMT grades, with the following exceptions: MMT 1/2 for knee flexion (women); and MMT 0/2 (men and women), 1/2 (men and women), and 3/4 (men) for ankle dorsal flexion.

Discussion

Previous reports suggested that the intratester [1, 13, 14] and intertester [15] reliability of DMT was relatively high. In agreement, we found strong correlations between F1 and F2 in the present study, with the exception of ankle dorsal flexion

Table 1. Results of manual muscle test (MMT) and handheld dynametric muscle test.

Joint	Motion		Average Fmax (SD) / number					
		MMT	0	1	2	3	4	5
Hip	Flexion	Men	0.0 (0.0) / 32	0.0 (0.0) / 20	32.7(29.3) / 48	71.7 (24.5) / 58	114.8 (46.0) / 110	174.0 (53.7) /79
			n.s. (0–1)					
		Women	0.0 (0.0) / 22	0.8 (6.5) / 64	20.4 (25.3) / 107	59.4 (29.5) / 129	96.7 (35.8) / 213	138.2 (38.4) /75
			n.s. (0–1)					
	Extension	Men	0.0 (0.0) / 14	1.1 (7.5) / 43	33.6 (33.4) / 67	71.7 (31.3) / 51	110.8 (35.1) / 88	162.2 (40.3) /84
			n.s. (0–1)					
		Women	3.2(13.8) / 19	0.0 (0.0) / 57	22.6 (24.3) / 99	58.2 (36.0) / 125	100.1 (37.5) / 199	136.6 (38.9) / 108
			n.s. (0–1)					
	Abduction	Men	0.0 (0.0) / 18	2.1 (11.8) / 33	54.8 (41.8) / 100	94.2 (37.4) / 47	120.4 (39.2) / 76	169.2 (47.8) / 75
			n.s. (0–1)					
		Women	0.0 (0.0) / 13	5.1(13.6) / 38	40.2 (32.8) / 172	80.3 (34.8) / 126	101.2 (39.0) / 178	134.2 (44.1) / 88
			n.s. (0–1)					
Knee	Flexion	Men	1.2 (5.5) / 44	7.0(17.0) / 33	13.0 (15.6) / 45	47.3 (27.2) / 44	92.7 (40.0) / 92	138.7 (52.8) / 74
			n.s. (0–1)					
		Women	0.0 (0.0) / 37	2.3 (5.3) / 55	10.7 (11.4) / 69	34.7 (21.6) / 115	74.4 (30.7) / 196	98.2 (35.1) / 83
			n.s. (0–1)	n.s. (1–2)				
	Extension	Men	0.0 (0.0) / 52	0.0 (0.0) / 27	12.2 (16.1) / 55	41.1 (46.3) / 27	114.4 (59.1) / 53	225.6(118.2) / 119
			n.s. (0–1)					
		Women	0.0 (0.0) / 54	0.0 (0.0) / 42	11.4 (28.7) / 74	31.4 (30.8) / 76	90.2 (60.1) / 125	156.4 (68.0) / 184
			n.s. (0–1)					
Ankle	Dorsal flexion	Men	33.0(64.9) / 82	19.8(59.2) / 21	26.3 (29.0) / 23	70.5 (47.0) / 35	101.6 (47.5) /57	157.0 (46.2) / 108
			n.s. (0–1); n.s. (0–2)	n.s. (1–2)		n.s. (3–4)		
		Women	29.3(49.2) / 75	18.9(414) / 34	31.1 (35.9) / 46	66.1 (51.7) / 78	92.9 (39.0) / 140	131.8 (41.0) / 209
			n.s. (0–1); n.s. (0–2)	n.s. (1–2)				

measurements.

The presence of significant differences in Fmax values between the adjacent MMT grades from grade 1 to 5 for the hip and knee motions (except between MMT 1 and 2 in knee flexion for men) indicated that the grading was generally acceptable. However, DMT results >0 N were obtained in a few cases with MMT grades 0 or 1, where no muscle output was expected based on the definitions. This could partially originate from compensatory motion in other joints. In this regard, determination of MMT as grades 0 and 1 requires careful examination for any of the hip and knee motions.

There were many cases with markedly different F1 and F2 for ankle dorsal flexion. Significant differences in the corresponding Fmax values were present between contiguous MMT grades in the 2−5 range. However, the average Fmax values were >30 and >20 N, respectively, for the cases with MMT grades 0 and 1, where 0 N muscle output was expected according to the definition. Ankle dorsal flexion requires especially careful assessment.

Despite such problems, MMT measurements were considered generally acceptable regardless of gender, because significant differences in muscle strength were observed for the majority of pairs of MMT grades.

This study has some limitations. First, muscle power in healthy individuals has been reported to be affected by age, side (dominant or non-dominant), height and weight in addition to gender [6, 7]. Although the age of the study subjects was substantially restricted by the limited time period in which poliomyelitis had occurred, the effects of the other factors may need to be considered in future studies. Second, inter- and intratester reliability was not examined in this study. The examiner's strength reportedly limits the detection of moderate quadriceps weakness via manual resistance [16]. It might be necessary to investigate the relationship between MMT grades and quantified muscle strength obtained during DMT for each examiner. On the other hand, given that a large number of physical therapists participated in the present study, the results may be considered to correspond to an average clinical situation. Furthermore, it may be easier to assign MMT grades for many other disorders where the apparently healthy side can be used as a control.

Conclusions

Routine clinical MMT measurements are generally acceptable, at least when they are performed by physical therapists with 5 or more years of clinical experience.

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