

The Ability of Male and Female Clinicians to Effectively Test Knee Extension Strength Using Manual Muscle Testing

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As part of a physical examination, muscle strength assessment aids clinicians in measuring progress, developing a treatment plan, and generating a differential diagnosis (7,15). In the clinic, strength assessment often has involved some form of manual muscle testing. The most common system utilizes Lovett's guidelines (13). This grading system is based on the ability to move the limb against gravity for grades up to Fair, while grades above Fair depend on the examiner's perception of the patient's ability to hold against manual resistance. Over 30 years ago, Beasley documented that clinicians failed to detect substantial weakness in the larger lower extremity muscle groups during manual muscle testing (4). He found that the mean force of the quadriceps in patients with polio who had a knee extension grade of Normal was only 53% of that in normal subjects. Those with a knee extension grade of Good averaged only 42% of the quadriceps' force in the normal subjects.

Since then, efforts have been made to objectify and quantify strength testing through the use of isokinetic devices, strain gauges, and hand-held dynamometers (3,4,7-9, 16). Hand-held dynamometry eliminates the subjective interpretation required in manual muscle testing

and is, therefore, more sensitive to strength differences in patients (2,7, 15). Like manual muscle testing, however, the detection of weakness is dependent upon the examiners' ability to produce more force than the patient in the testing position. Examiner strength, therefore, may limit testing accuracy (9,14,15). Wilkholm and Bohannon have been the only investigators to systematically evaluate the influence of examiner strength on muscle testing (17). They documented that examiner strength be-

It has been suggested that the accuracy of manual muscle testing is dependent on examiner strength. Our purpose was to relate male and female clinicians' upper extremity strength to their ability to challenge the quadriceps and detect weakness in patients using manual muscle testing. Quadriceps muscles of seven men and 12 women with postpoliomyelitis were tested manually by a male and female clinician while forces were recorded with a hand-held dynamometer. Patients' maximal isometric knee extension force was recorded with a Lido dynamometer and clinicians' maximal vertical push force was recorded with the hand-held dynamometer. Manual muscle testing forces, patient maximum quadriceps forces, and examiner push forces were compared with repeated measures analysis of variance. Female examiners' maximal vertical push force (235.7 ± 54.3 N) was not significantly different from either female or male patients' maximal quadriceps force (166.8 ± 66.7 N and 341.6 ± 123.7 N) but was only 60% and 40% of the isometric knee extension forces generated by a group of normal women and men. Male examiners were significantly stronger (357.0 ± 93.4 N) than the female but not the male patients and produced 90% and 60% of the normal isometric quadriceps forces for women and men. Examiners gave appropriate grades in 30 of 38 tests. Examiner strength limits detection of moderate quadriceps weakness with manual resistance. Most of the muscle test grades, however, were appropriate, given the examiner's upper extremity strength. Clinicians using manual muscle testing should determine their maximal vertical push force and the extent of weakness they can detect.

Key Words: manual muscle testing, muscle strength, quadriceps, postpolio syndrome

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inert strength, therefore, may limit testing accuracy (9,14,15). Wilkholm and Bohannon have been the only investigators to systematically evaluate the influence of examiner strength on muscle testing (17). They documented that examiner strength be-

came a major determinant in the reliability of hand-held dynamometer testing for muscle groups that generated a mean maximum force above 120 N. They were unable, however, to directly compare the examiner's and the patient's maximal force-producing capability. They did not measure the upper extremity force of the examiners in the position and direction of the muscle test but, rather, recorded upper extremity torque in shoulder flexion/elbow extension and shoulder extension/elbow flexion combinations and reported only the mean of the two torques. Since they did not measure the subject's maximal quadriceps force against a stationary device, the subjects' maximal capability was not known. In addition, the manual muscle test of the quadriceps in their study was performed in 90° of knee flexion which is not the position recommended by manual muscle testing texts (11,12). Finally, the influence of gender on the strength of the examiner or the subject has not been documented.

The purpose of this study was two-fold. The first objective was to relate the maximal vertical push force of the dominant upper extremity in a group of male and female clinicians to their ability to challenge the maximal quadriceps force in male and female postpoliomyelitis patients during manual muscle testing. The patient's maximal quadriceps force was defined as that force produced during a maximal isometric knee extension effort on a Lido dynamometer (Loredan Biomedical, Davis, CA). The second objective was to quantify the extent to which these clinicians were able to and did detect knee extension weakness with the manual muscle testing grades.

METHODS

Subjects

Nineteen volunteers, recruited from the Polio Clinic at Rancho Los Amigos Medical Center, Downey, CA,

with the diagnosis of postpolio syndrome participated as subjects. Subjects included 12 women and seven men (mean age = 56.8). None had acute muscular pain or fatigue, and all were able to extend their knee fully against gravity. The eight examiners from the Rancho Los Amigos Medical Center staff included four female and four male clinicians. Female testers consisted of one physical therapist, one orthopaedist, and two neurologists. The four male testers included one physical therapist, one neurologist, one orthopaedist, and one physiatrist. All clinicians were routine users of manual muscle testing who utilized this evaluation technique on a weekly basis. All subjects and examiners signed an informed consent statement.

Procedure

Maximal knee extension torque of the postpolio patients was recorded with a Lido dynamometer. Patients sat with the back rest reclined 20° from vertical and with the tested knee flexed 20° from full extension. The axis of the Lido lever arm was aligned with the axis of the knee joint, and the padded cuff of the dynamometer arm was placed just proximal to the malleoli. The subjects performed two 5-second contractions of maximum isometric knee extension with a 2-minute rest period between trials.

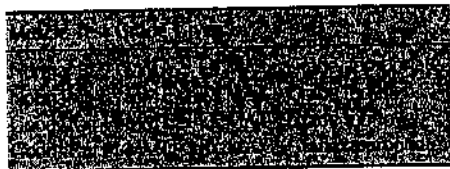
Maximal push capability of the examiners was documented by measuring their vertical push force exerted against a stationary Lido lever arm using a microFET hand-held dynamometer (Hogan Health Industries, Draper, UT). The Lido lever arm, positioned at 20° below the horizontal, simulated the position of the tibia during a quadriceps manual muscle testing. Each examiner performed two 5-second trials pushing downward against the stationary lever arm with the microFET. A research investigator (SM or SC) recorded the force readings from the microFET

while the examiner was blind to the values, and the higher of the two values was used for data analysis.

Each patient was evaluated with manual muscle testing in one session by one female and one male examiner from different disciplines. This resulted in 38 patient-examiner pairs. The patient was seated on a plinth during the muscle test. The examiner applied resistance to the anterior surface of the distal tibia with the hand-held dynamometer interposed between the examiner's hand and the subject's leg. The patient's knee was flexed approximately 20°. The force produced during manual muscle testing of the quadriceps was measured with the microFET dynamometer. The examiner assigned a descriptive grade. Lovett's descriptors of Normal, Good, and Fair were used, with the addition of a plus or minus for intermediary levels of Good and Fair. A research investigator (SM or SC) recorded the manual muscle testing grades, the microFET force reading measurements, and the lever arm that the examiner used for each test. The lever arm was defined as the perpendicular distance from the point of application of resistance to the knee joint axis of rotation. Both patients and examiners were blind to the microFET force readings, and the examiners were blind to the manual muscle testing grade given by the other clinician.

Data Analysis

The larger of the two peak knee extension torque values recorded on the Lido dynamometer was used to calculate each patient's maximal knee extension force. Maximum quadriceps force was calculated by dividing the isometric torque by the lever arm that had been used with the patient during manual muscle testing. This value represented the push force that the examiner needed to resist that patient's maximal quadriceps torque with the lever arm used during the manual muscle test.



MMT = Force produced on the hand-held dynamometer during manual muscle test.

EX MAX = Maximal vertical push force of the examiner measured on the hand-held dynamometer.

TABLE 1. Assessment criteria of manual muscle test grades.

A two-way analysis of variance was used to compare the testers' vertical push force, the patients' maximal quadriceps force, and the force produced during manual muscle testing with a grouping factor for male and female patients. Separate analyses were conducted for the male and female examiners. When a significant interaction between patient gender and torque was found, simple main effects testing was used to determine the force differences for each group. Post hoc testing with a Bonferroni correction was conducted to determine where the significant differences occurred.

The criterion of a force produced during manual muscle testing of at least 90% of the patient's maximum force on the Lido was established to signify that the patient's quadriceps had been maximally challenged during the manual muscle test. This standard was set to allow for the normal variability of a maximal effort (10).

Criteria were set to determine if an appropriate muscle grade was given. This standard was based on the examiner's maximum push force and the force produced during manual muscle testing. In any instance where the force produced during the manual muscle test was equal to or greater than the examiner's push force, the appropriate grade was Normal. When a grade of Normal was given, and the manual muscle testing force was less than the examiner's maximum, the grade was considered too high (Table 1).

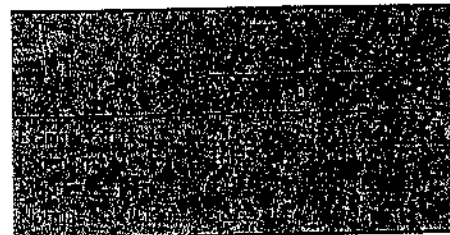
A grade of Good or Fair+ was considered appropriate when the manual muscle testing force was less than the examiner's maximal vertical push force capability. Conversely, when the manual muscle testing force matched or exceeded that of the examiner's maximal push force, a grade of Good or Fair+ was concluded to be too low.

RESULTS

Despite the large variability in the strengths of the four subject groups studied, differences in the tester's ability to match patients' quadriceps strength and detect weakness were found between male and female examiners. These differences also were dependent on the gender of the patient. The data will be described in three major categories: 1) testing potential, which relates the maximum strengths of the examiners and patients; 2) testing reality, which refers to the actual forces generated by the examiners and patients during manual muscle testing; and 3) testing outcome, which reflects the clinical grades assigned.

Female Examiners

Testing potential: Maximum examiner push force vs. patients' maximal quadriceps force The maximum vertical push force of female examiners (235 ± 54.3 N) was not significantly different from the maximum quadriceps force of either the male patients (341.6 ± 27.8 N) or the female patients (166.8 ± 66.7 N) (Table 2). Male patients' knee extension force ranged from 112.1 N to 513.7 N and the female patients' forces were from 93.8 N to 288.7 N. The strength of the female examiners varied from 165 N to 285 N. Female testers were stronger than 10 of the 12 female patients and only one of the seven male patients (Figure 1). Despite the seemingly large difference between the female testers' strength and the strength of the male subjects, no sta-



* $p < .05$ when compared with female examiner manual muscle testing force.

* Normative values based on unpublished data (15 women and 20 men, aged 20-39 years, mean = 28 years).

Examiner max = Mean maximum vertical push force of the female examiners as measured on the hand-held dynamometer.

Patient max = Mean maximal isometric knee extension force of the patients measured on the Lido dynamometer.

Muscle test force = Force produced during manual muscle testing performed by a female examiner and recorded by the hand-held dynamometer.

Normal max = Mean maximal isometric knee extension force of a group of normal subjects measured on the Lido dynamometer.

TABLE 2. Female examiners' maximal push force and muscle test forces compared with patients' and normal subjects' maximal quadriceps capability (measured in newtons).

tistically significant difference was found due to the small number of male patients and the inclusion of one very weak male subject.

Testing reality: Manual muscle testing force vs patients' maximal quadriceps force The force produced by female examiners during manual muscle testing of the female patients (148.6 ± 63.6 N) was not significantly different from that of the female patients' maximum force on the Lido (166.8 ± 66.7 N). When testing male patients, however, the manual muscle testing forces produced with female examiners (191.3 ± 84.1 N) was significantly less than the male patient maximum force (341.6 ± 123.7 N) ($p < .05$). Seven of the 12 female patients and all of the male subjects failed to produce 90% of their maximum knee extension force when tested by the female examiners (Figure 2).

Testing reality: Manual muscle testing force vs. examiners' maximal vertical push force A statistically significant difference was found between the

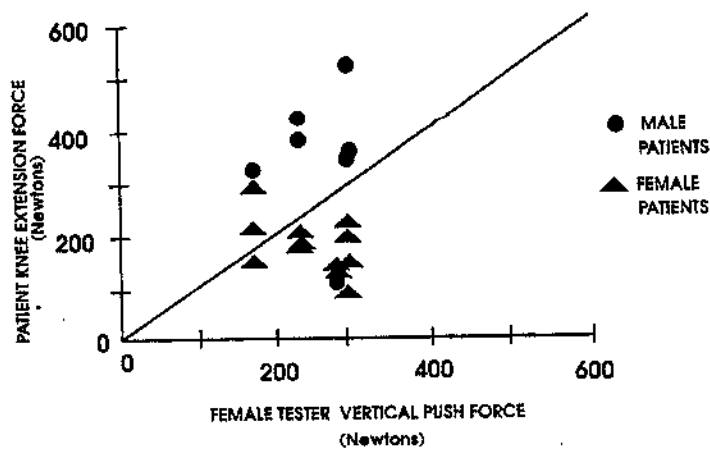


FIGURE 1. Relative strength of the female examiners' upper extremity and patients' quadriceps. Maximum vertical push force of the female testers recorded by the hand-held dynamometer is depicted on the x axis and patients' maximum knee extension force performed on the Lido is on the y axis. The diagonal line corresponds to a slope of 1.0. Any data point along the line represents equal patient and examiner force values. Data points above the line depict patients who were stronger than the examiner and those that fall below the line denote patients who were weaker than the examiners.

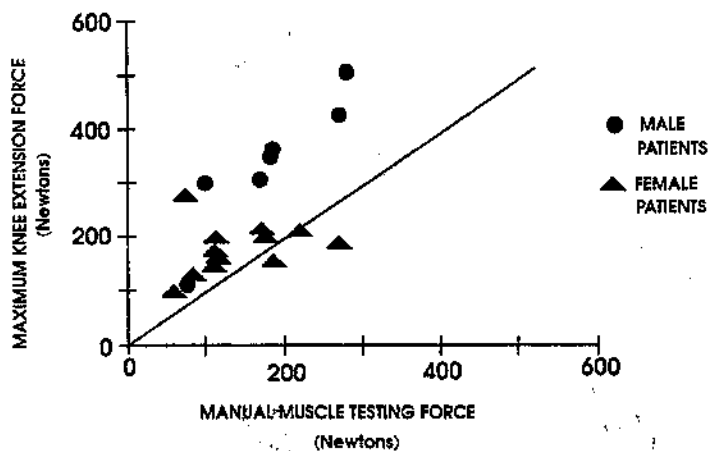


FIGURE 2. Extent of patient challenge during the manual muscle test with a female examiner. The force produced during manual muscle testing of the quadriceps recorded by the hand-held dynamometer is on the x axis and the maximal knee extension force produced by the patient on the Lido is on the y axis. The diagonal line represents a slope of 1.0. Data points falling above the line denote patients whose quadriceps were not adequately challenged during the manual muscle test by a female examiner.

female testers' maximal push force (235.7 N) and the force produced when testing female patients (148.6 N) ($p < .05$). Examiner's maximum push force was not significantly different, however, from the muscle testing forces of the male patients (191.3 N). Female examiners had a strength reserve during muscle testing of 10 of the 12 female patients and five of the seven male patients (Figure 3).

Testing outcome: Manual muscle test grades Female examiners assigned a grade of Normal to six male patients

and four female patients (Table 3). Seven female patients were given grades in the Good range (1 Good+, 4 Good, 2 Good-), and the grade Fair+ was assigned to one male and one female patient. Based on the criteria for clinical interpretation, the female examiners gave manual muscle testing grades that were appropriate for 14 of 19 patients. They gave muscle test grades that were too high for two female and two male subjects. The female examiners also assigned a grade that was too low for one fe-

male patient. Muscle grades of Normal corresponded to an average of 113% of the female examiners' maximum push force, a Good corresponded to 56% of examiner force, and a Fair+ was 26% of examiner maximum force.

Male Examiners

Testing potential: Maximum examiner push force vs. patients' maximal quadriceps force Male examiners' mean maximal vertical push force (357.0 ± 93.4 N) was similar to the male patients' mean maximal knee extension force on the Lido (341.6 ± 123.7 N) but was statistically significantly greater than that of the female patients' mean maximum capability (166.8 ± 66.7 N) ($p < .05$) (Table 4). The maximum vertical push forces of the male examiners ranged from 245 N to 454 N (Table 4). Four of the seven male patients produced a maximal quadriceps force that exceeded the force of the male tester, while none of the female patients was stronger than the male examiners (Figure 4).

Testing reality: Manual muscle testing force vs. patients' maximal quadriceps force The force produced during manual muscle testing by a male examiner was not statistically different than either the male or female patients' maximal knee extension force (Figure 5). Three of the seven male patients and two of the 12 female patients did not produce at least 90% of their knee extension maximum force when tested by a male examiner.

Testing reality: Manual testing force vs. examiners' maximal vertical push force

The male examiners had a strength reserve when testing four of the seven male patients and nine of the 12 female patients (Figure 6). Male examiner maximum push force was significantly greater than the manual muscle testing force produced when testing female patients (187.7 ± 86.7 N) ($p < .05$), but was

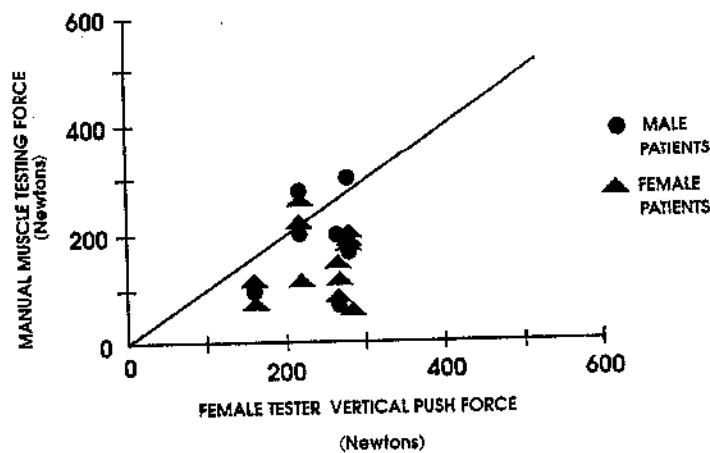
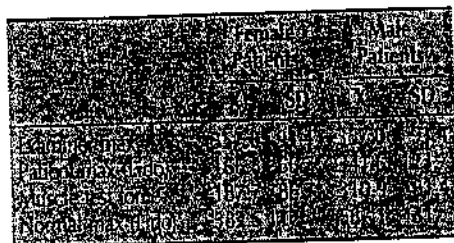


FIGURE 3. Extent of female examiner challenge during the manual muscle test of the quadriceps. Female examiner maximal vertical push force recorded by the hand-held dynamometer is on the x axis and the force produced during the manual muscle test of the quadriceps also recorded by the hand-held dynamometer is on the y axis. The diagonal line corresponds to a slope of 1.0. Data points that fall below the line represent instances when the female examiner had a strength reserve when manual muscle testing a patient's quadriceps muscle.

Subject	Female Max. Vertical Push Force (Newtons)	Manual Muscle Testing Force (Newtons)	Manual Muscle Testing Grade	Clinical Interpretation
1	150	100	Good	Correct
2	180	120	Good	Correct
3	200	150	Good	Correct
4	220	180	Good	Correct
5	250	200	Good	Correct
6	280	220	Good	Correct
7	300	250	Good	Correct
8	320	280	Good	Correct
9	350	300	Good	Correct
10	380	320	Good	Correct
11	400	350	Good	Correct
12	420	380	Good	Correct
13	450	400	Good	Correct
14	480	420	Good	Correct
15	500	450	Good	Correct
16	520	480	Good	Correct
17	550	500	Good	Correct
18	580	520	Good	Correct
19	600	550	Good	Correct
20	620	580	Good	Correct
21	650	600	Good	Correct
22	680	620	Good	Correct
23	700	650	Good	Correct
24	720	680	Good	Correct
25	750	700	Good	Correct
26	780	720	Good	Correct
27	800	750	Good	Correct
28	820	780	Good	Correct
29	850	800	Good	Correct
30	880	820	Good	Correct
31	900	850	Good	Correct
32	920	880	Good	Correct
33	950	900	Good	Correct
34	980	920	Good	Correct
35	1000	950	Good	Correct
36	1020	980	Good	Correct
37	1050	1000	Good	Correct
38	1080	1020	Good	Correct
39	1100	1050	Good	Correct
40	1120	1080	Good	Correct
41	1150	1100	Good	Correct
42	1180	1120	Good	Correct
43	1200	1150	Good	Correct
44	1220	1180	Good	Correct
45	1250	1200	Good	Correct
46	1280	1220	Good	Correct
47	1300	1250	Good	Correct
48	1320	1280	Good	Correct
49	1350	1300	Good	Correct
50	1380	1320	Good	Correct
51	1400	1350	Good	Correct
52	1420	1380	Good	Correct
53	1450	1400	Good	Correct
54	1480	1420	Good	Correct
55	1500	1450	Good	Correct
56	1520	1480	Good	Correct
57	1550	1500	Good	Correct
58	1580	1520	Good	Correct
59	1600	1550	Good	Correct
60	1620	1580	Good	Correct
61	1650	1600	Good	Correct
62	1680	1620	Good	Correct
63	1700	1650	Good	Correct
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65	1750	1700	Good	Correct
66	1780	1720	Good	Correct
67	1800	1750	Good	Correct
68	1820	1780	Good	Correct
69	1850	1800	Good	Correct
70	1880	1820	Good	Correct
71	1900	1850	Good	Correct
72	1920	1880	Good	Correct
73	1950	1900	Good	Correct
74	1980	1920	Good	Correct
75	2000	1950	Good	Correct
76	2020	1980	Good	Correct
77	2050	2000	Good	Correct
78	2080	2020	Good	Correct
79	2100	2050	Good	Correct
80	2120	2080	Good	Correct
81	2150	2100	Good	Correct
82	2180	2120	Good	Correct
83	2200	2150	Good	Correct
84	2220	2180	Good	Correct
85	2250	2200	Good	Correct
86	2280	2220	Good	Correct
87	2300	2250	Good	Correct
88	2320	2280	Good	Correct
89	2350	2300	Good	Correct
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114	2980	2920	Good	Correct
115	3000	2950	Good	Correct
116	3020	2980	Good	Correct
117	3050	3000	Good	Correct
118	3080	3020	Good	Correct
119	3100	3050	Good	Correct
120	3120	3080	Good	Correct
121	3150	3100	Good	Correct
122	3180	3120	Good	Correct
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155	4000	3950	Good	Correct
156	4020	3980	Good	Correct
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158	4080	4020	Good	Correct
159	4100	4050	Good	Correct
160	4120	4080	Good	Correct
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276	7020	6980	Good	Correct
277	7050	7000	Good	Correct
278	7080	7020	Good	Correct
279	7100	7050	Good	Correct
280	7120	7080	Good	Correct
281	7150	7100	Good	Correct
282	7180	7120	Good	Correct
283	7200			

cal push force of the female examiners was only 60% of normal knee extension force for women and 40% of the normal knee extension force value for men. The findings in this study confirm Beasley's conclusion that a grade of Normal could over-



* $p < .05$ when compared with male examiners' maximal vertical push force.

† Normative values based on unpublished data (15 women and 20 men, aged 20-39 years, mean = 28 years).

Examiner max = Mean maximum vertical push force of the male examiners as measured on the hand-held dynamometer.

Patient max = Mean maximal isometric knee extension force of the patients measured on the Lido dynamometer.

Muscle test force = Force produced during manual muscle testing performed by a male examiner and recorded by the hand-held dynamometer.

Normal max = Mean maximal isometric knee extension force of a group of normal subjects measured on the Lido dynamometer.

TABLE 4. Male examiners' maximal push force and muscle test forces compared with patients' and normal subjects' maximal quadriceps capability (measured in Newtons).

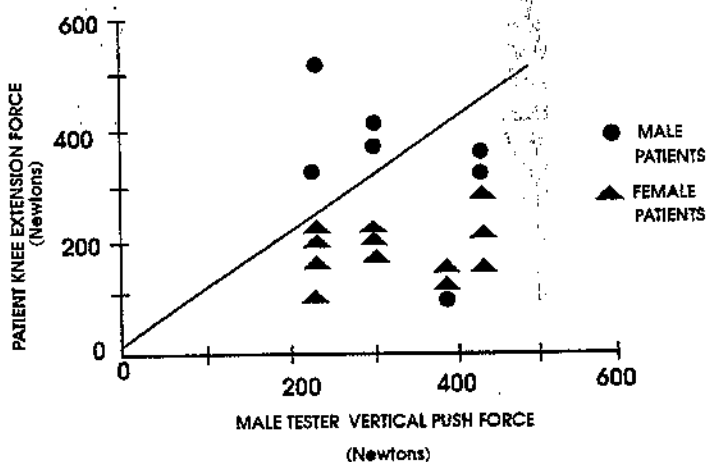


FIGURE 4. Relative strength of the male examiners' upper extremity and patients' quadriceps. Maximal vertical push force of the male testers recorded by the hand-held dynamometer is depicted on the x axis and patients' maximum knee extension force performed on the Lido is on the y axis. The diagonal line corresponds to a slope of 1.0. Any data points along the line represents equal patient and examiner values. Data points above the line depict patients who were stronger than the examiner and those that fall below the line denote patients who were weaker than the examiners.

estimate quadriceps strength by as much as 50% (4). This group of female patients had a mean quadriceps force that was 40% of the normal strength for women, while the force of the male patients was 60% of the normal male value. These numbers indicate that this group of female examiners should have been able to detect weakness in each of these female patients, but they would have missed significant weakness in this group of male patients. Given their maximal vertical push forces, this group of female examiners would be unable to detect mild to moderate weakness in either a female or male subject.

A comparison of the male examiner maximal push force with the force of the quadriceps in normal subjects indicated they could detect even subtle weakness in female patients, but might miss moderate weakness in male subjects. Male testers' vertical push force was 96% of the normal knee extension value for women, but only 61% of the normal male knee extension force. Because the female postpolio patients' quadriceps force was only 40% of normal, and male patients' knee extension force was 60% of the normal value,

these patients were sufficiently weak that the male examiners were capable of challenging all subjects except the strongest men.

Given the examiners' maximum vertical push capability, both male and female clinicians have a high probability of overestimating knee extension strength of male patients when using manual muscle testing. Female examiners run this risk with female patients as well. The normal values used for comparison in this study are similar to the forces produced by the normal subjects in the 20- to 50-year-old age brackets in Bohannon's study (6) but approximately 30% higher than the normal values reported by Andrews et al (3), who tested 50- to 79-year-old subjects. Although both studies tested the quadriceps with a hand-held dynamometer, Bohannon reported that the tester in his study was approximately one standard deviation above the mean for his age in grip strength, thereby representing the upper end of capability for male examiners. Our examiners, particularly the female testers, would have been unable to match the normal quadriceps forces of the subjects in either study.

What these data did show, however, was that, in most instances, the clinicians were correct in their clinical interpretation of the manual muscle testing, given their theoretical potential to resist the patients' maximal capability. In four of the 19 cases, the female examiners assigned a grade of Normal when their maximum vertical push force was not matched. In one of those cases, the examiner's maximum force exceeded that of the patient, but the force generated during manual muscle testing was less than the female subject's maximum knee extension force. In only one instance did a female examiner underrate a patient. Although the force produced during the manual muscle testing was equal to the examiner maximum, she graded the patient a Good+. In the two instances where the male examiners

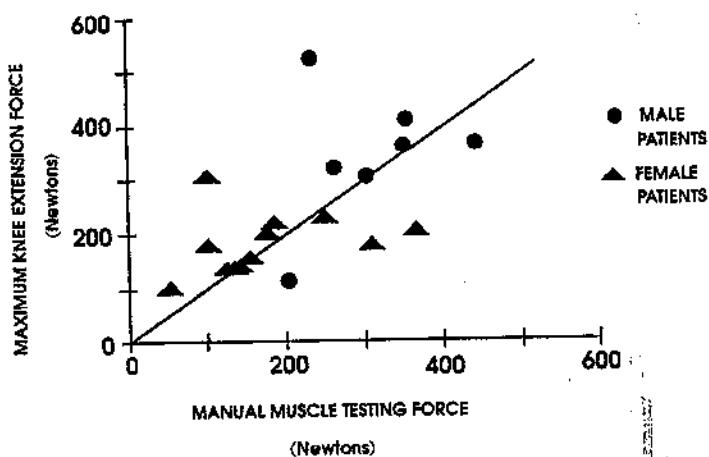


FIGURE 5. Extent of patient challenge during the manual muscle test with a male examiner. The force produced during manual muscle testing of the quadriceps by a male examiner recorded by the hand-held dynamometer is on the x axis and the maximal knee extension force produced by the patient on the Lido is on the y axis. The diagonal line represents a slope of 1.0. Data points falling above the line denote patients whose quadriceps were not adequately challenged during the manual testing by a male examiner.

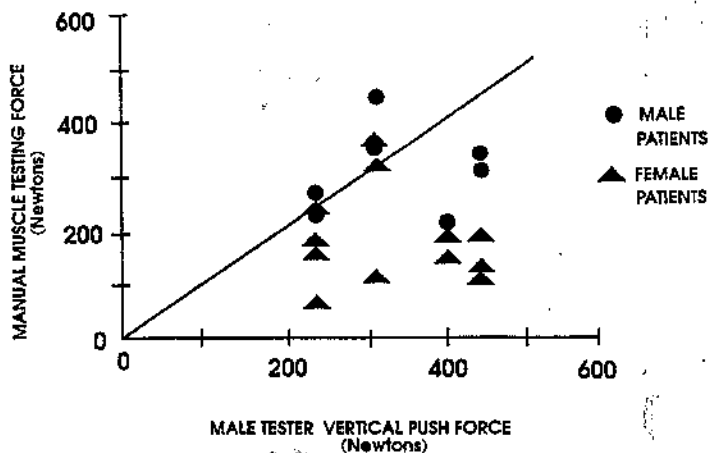


FIGURE 6. Extent of male examiner challenge during the manual muscle test. Male examiner maximal vertical push force recorded by the hand-held dynamometer is on the x axis and the force produced during the manual muscle test of the quadriceps also recorded by the hand-held dynamometer is on the y axis. The diagonal line corresponds to a slope of 1.0. Data points that fall below the line represent instances when the male examiner had a strength reserve when manual muscle testing a patient's quadriceps muscle.

gave a manual muscle testing grade that was too high, a grade of Normal was assigned to subjects whose maximum force was matched in the manual muscle testing, but the manual muscle testing force was well below that of the examiner. This implies that even with the patients pushing as hard as they could, the examiner should have been able to overcome the quadriceps force. In one instance, a grade of Good+ was given when the manual muscle testing force exceeded the examiner's maxi-

mum vertical push force while the patient's maximum knee extension force was well above the maximum push force of the examiner.

There was a total of eight cases where the examiner, either male or female, was stronger than the patient, but the force produced during the manual muscle testing was less than 90% of the patient's maximum value. Examiner strength, then, was not the limiting factor in the low force production in the manual muscle testing. The low muscle test forces could

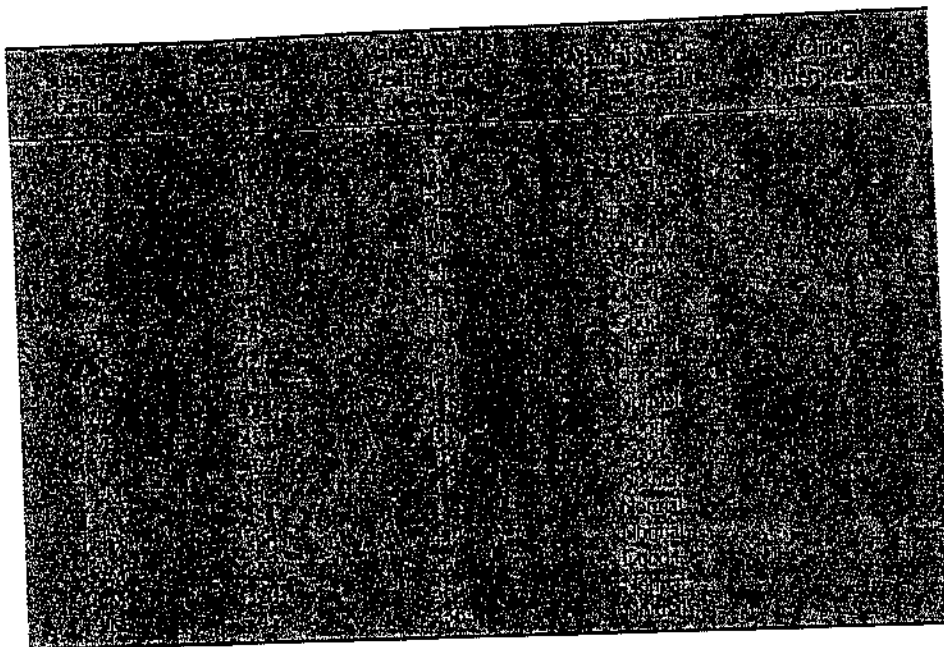
be attributed, therefore, to a reduced or variable patient effort. In all of these instances, however, an accurate muscle grade was given, and weakness was correctly identified.

The disparity between the low manual muscle testing force in patients with a higher maximum force may be related to individuals who are more willing to exert a higher force against a stationary object than against another person. The Lido also provides a more stable object for the patient to push against than the hand-held dynamometer on the tibia.

Another limiting factor in manual muscle testing may lie in a patient's perception of the examiner's strength.

Another limiting factor in manual muscle testing may lie in a patient's perception of the examiner's strength. In 13 of the 19 muscle tests, the patient exerted more force when pushing against a male examiner than when tested by a woman. In over half of those cases, the force produced during the manual muscle test was less than the female examiner's maximum force. This implies that examiner strength would not account for the lower manual muscle testing values. The patient's perception of the strength of his or her examiner may have influenced the amount of effort exerted during a manual muscle testing.

Studies concerned with validating the hand-held dynamometer as an effective strength assessment tool show that the use of a hand-held dynamometer adds sensitivity and objectivity to traditional manual muscle testing (1-3,5). The results of this



√ = Correct clinical interpretation.
 + = Manual muscle testing grade too high.
 - = Manual muscle testing grade too low.
 Exam max = Maximal vertical push force of the examiner measured with a hand-held dynamometer.

TABLE 5. Evaluation of manual muscle test grades given by male examiners.

study, however, indicate that the utility of the hand-held dynamometer is limited by the strength of the examiner. This conclusion is supported by an earlier work by Marino et al where discrepancies in two examiners' ability to detect weakness in the hip abductors were attributed to differences in their strength (14). The hand-held dynamometer readings taken during manual muscle testing were reflective of the examiner's strength rather than the patient's ability in those cases where the patient was stronger than the examiner. Only in the case of male examiners testing female patients did the hand-held dynamometer reading accurately reflect the subjects' maximal knee extension force.

CONCLUSIONS

This study has demonstrated that the utility of manual muscle testing for the larger lower extremity muscles lies in detecting significant clinical weakness, rather than identifying slight decreases in strength. Because strength is an individual attribute,

routine users of manual muscle testing should determine his or her own push capability, ie., self-calibration. Knowing one's own strength, along with the magnitude of normal quadriceps force, would enable the clinician to refer patients for objective isometric or isokinetic strength testing when manual muscle testing failed to detect suspected weakness. Conversely, when an examiner was successful in resisting the patient's effort, knowing the percentage of normal strength that one can resist manually would provide a clinician with an estimate of the extent of the patient's weakness.

JOSPT

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