INVESTIGATION OF METHODS AND STYLES OF MANUAL MUSCLE TESTING BY AK PRACTITIONERS

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Paper submitted June 12, 2003; in revised form June 29, 2004.
Sources of Support: This study was funded by the International College of AK – USA Chapter.

ABSTRACT

Objective: Establishing objective descriptive data regarding manual muscle testing (MMT) as used in Applied Kinesiology, including "patient-started" versus "examiner-started" variations, is necessary before research pertaining to the reliability and clinical significance of this procedure is done. This study measured surface electromyography (sEMG) output from experienced MMT practitioners and their tested subjects during the performance of sequential MMT on the same muscle during 3 styles of MMT: normally-done, examiner-started and patient-started.

Methods: 21 examiners experienced in MMT and 24 subjects with varying degrees of exposure to MMT were engaged in the study. sEMG was simultaneously recorded from examiner and subject during testing of the middle deltoid muscle. The examiner first tested the middle deltoid muscle of the subject in his/her normal fashion 3 times and identified the MMT style as "examiner-started" or "patient-started." He/she was then asked to perform the other method of MMT. If the examiner said he/she did not know or did not differentiate which form of testing was initially done, he/she then performed one series each of examiner- and patient started MMT.

Results: Nine (approximately 43 %) of testers identified their "normally done" muscle test as examiner-started, 4 (19%) as patient-started and 8 (38%) as simultaneous or undifferentiated. In 64.5% of the MMT described as examiner started, sEMG showed that the examiner's contraction started before the patient's. In tests identified as patient started, 54% were indeed patient started. Undifferentiated tests were 45% patient-started, 45% examiner started and 10% exactly simultaneous. Near simultaneous contractions were observed in 55% of all tracings evaluated and 70% of undifferentiated tests.

Conclusions: While many MMT practitioners consider that they are performing either an examiner- or patient-started muscle test, a significant number do not make this distinction routinely. The majority of testers in this study did near-simultaneous testing regardless of label. Examiner and subject start times alone, as measured by sEMG, did not clearly differentiate between theorized forms of manual muscle testing. (J Chiropr Med 2005;4:1–10)

Key Indexing Terms: Chiropractic; Muscles; Electromyography

INTRODUCTION

Manual muscle testing (MMT) has a long history of use in medicine, chiropractic, and physical therapy as a means of evaluating neuromuscular function and pathology. As early as 1915, MMT was used to evaluate patients with infantile paralysis.[1] Applied Kinesiology (AK) MMT was developed from procedures described by Kendall, Kendall and Wadsworth[2] in their book *Muscles—Testing and Function*. Kendall and Kendall describe a 5 point grading system to report muscle strength, which has been expanded and elaborated on in later editions.[3] Goodheart[4] uses a binary grading system of "strong/normally facilitated" (corresponding roughly to Kendall and Kendall's grade 5 or "Normal") vs. "weak/functionally inhibited" (corresponding roughly to Kendall and Kendall's grade 4 /good and below). A "strong" muscle is one that successfully resists the examiner's gradually increasing pressure, "locking" or maintaining an isometric contraction and a "weak" one is one which cannot resist moderate pressure and breaks away.

This type of muscle testing is used to evaluate neurological effects on muscle function, rather than the absolute number of pounds of force the muscle can generate. Clinically, AK muscle testing is used world-wide by chiropractors, medical doctors, naturopaths, physical therapists, and acupuncturists as a

0899-3467/05/1002-049$3.00/0
JOURNAL OF CHIROPRACTIC MEDICINE

pre- and post-evaluation of the effects of various functional challenge stimuli and treatments. According to the most recent Job Analysis of Chiropractic published by the National Board of Chiropractic Examiners, AK is used by 43.2% of chiropractors in the United States.[5]

Caruso and Leisman[6] demonstrated that the judgment of clinicians with 5 or more years of experience with AK muscle testing was accurate 98% of the time with regard to normal facilitation or functional inhibition of muscle, using examiner-started muscle testing, compared with a displacement vs. force over time model. In another paper, Caruso and Leisman[7] thoroughly discuss the clinical use of MMT in AK and issues of subjectivity and witting and unwitting error in muscle testing, concluding that, "The data indicate that AK muscle testing is a method capable of reliably and objectively discriminating the state of conditional facilitation or inhibition of a muscle." Leisman and Zenhausern[8] showed significant difference between force/integrated electromyography (EMG) ratios for muscles labeled "strong" and "weak" by prescreening with patient-started muscle testing, as well as reduced efficiency of the muscle contraction in weak muscles. Muscles subjectively tested as weak or strong demonstrated significant objective differences from fatigue in this study.

A commonly cited objective method of measuring muscle strength deficits is "break testing," using a dynamometer to measure the maximum force generated by the muscle just before it breaks away comparing the same muscle on each side of the body to determine whether a strength deficit exists. [9–11] "Break testing" of this type is documented in the physical therapy and physical education literature, with known reliabilities for group muscle tests. In these studies, the muscle is tested to the breaking point each time. Several authors have described AK muscle testing as having similarities to "break testing."[12–14] The most commonly described form of "break testing" which uses a dynamometer and measures peak forces, is different from AK testing. In AK testing, the normal ability to maintain the contraction against the test is determined by the tester, the test is stopped, and the muscle is only taken to the breaking point when it is noticeably dysfunctional. This would be equivalent to Kendall and Kendall's grade 4.[1] Kendall, McCreary and Provance also refer to break testing in a way which better matches the methods used by applied kinesiologists:[3]

> "For grades above fair, pressure is applied in addition to the resistance offered by gravity. A *break test* is a muscle strength test to determine the maximal effort exerted by a subject who is performing an isometric contraction as the examiner applies a *gradual* build-up of pressure to the point that the effort by the subject is overcome. It is used in determining grades of fair+ through good+.
>
> No effort is made to break the subject's hold if the examiner has determined that the strength is normal; to continue exerting force to make the muscle yield by performing a break test is unnecessary and may be injurious."

Because the term "break testing" is often used to apply to a style of examination different in important respects from AK muscle testing, the authors recommend the term "AK muscle testing" for AK research and communications, with a complete description of the tests done, rather than use of the term "break testing."

In 1986 Schmitt[15] brought potential differences in outcomes of 2 methods of AK muscle testing to the attention of the AK community. One of these is examiner-started testing, in which the patient is instructed to resist the examiner's gradually increasing pressure. It was originally described as an eccentric contraction by the subject. The other method is patient-started testing, in which the patient is instructed to push against the examiner's hand and at the point where the examiner feels that maximum contraction has been achieved, the examiner adds pressure to see if overcoming of the muscle contraction is possible, described as concentric/isometric.

Schmitt postulated that examiner-started testing evaluates the integrity of the dynamic response via the nuclear bag, primary afferents, and the gamma-1 motorneuron pathway. He further postulated that examiner-started MMT reflected spinal-level sources of inhibition to the alpha motorneuron. Patient-started testing is postulated to reflect the integrity of the static response, via the nuclear chain, secondary afferents, and the gamma 2 motorneuron pathways and to be sensitive to supraspinal sources of inhibition, such as cranial faults, nutritional deficiencies, and TMJ problems. Although there have been subsequent modifications to the details of the neurological model, the basic spinal/

supraspinal clinical distinction has continued to be used by many applied kinesiologists in interpreting results of MMT.

Schmitt described Goodheart's muscle testing and that of most applied kinesiologists in 1986 as examiner-started. Gerz[16] proposed a theoretical model to differentiate examiner-started vs. patient-started testing based on force applied over time vs. displacement of the tested limb. No experimental data was presented in support of this model. He described Goodheart's testing as patient-started. He advocated the adoption of patient-started testing as the standard in AK based on Goodheart's purported use of it and on theoretical grounds to avoid false positive results from the examiner overwhelming the patient before the patient had a chance to respond fully. As a result of this theoretical paper, patient-started MMT has been adopted as a standard by many European applied kinesiologists, while many non-European applied kinesiologists continue to use examiner-started testing as their usual test or to use both methods, depending on the clinical situation, respecting the admonitions of Kendall and Kendall, Walther and others regarding gradual application of force by the examiner.

A similar theoretical paper was recently presented by Baker[17] wherein he hypothesized, like Gerz, about differences that might be seen in linear force/ displacement graphs of examiner-started vs. patient-started muscle testing. These hypotheses have yet to be tested. Controversy has continued in the AK community over which form of muscle testing is most appropriate. Differences in testing style are a potential confounder in studies of inter-examiner reliability of MMT and may explain inconsistent results found on different muscles in various studies.[13] Quantification of the actual practice is a necessary first step toward standardization of these styles. Outstanding questions can only be resolved with objective data, clear definitions and operational descriptions for future research and clinical application.

Kendall and Kendall[2] clearly describe examiner-started testing, with an emphasis on gradual addition of force by the examiner and avoiding sudden applications of force. Tracing these concepts in the medical literature, these differences in muscle testing descriptions can be found in Chusid and McDonald's neurology text[18,19] as early as 1967: "Two techniques of testing may be used: active motion against the examiner's resistance and resistance against a movement performed by the examiner." In 1990 Hsieh and Phillips[14] published a study comparing the reliability of examiner-started vs. patient-started MMT, using Schmitt's model, with a computerized dynamometer. They describe only the patient-started test as being a "break" test, and not the examiner-started test. Other descriptions of "break" testing are clearly examiner-started.[3–6] Hsieh and Phillips measured reliability of the two methods in terms of strength in pounds and did not comment on the reliability of the AK outcome decision of whether the muscle was "strong/ normally facilitated" (normal, grade 5) or "weak/functionally inhibited"(good or grade 4 or below). They concluded that manual dynamometry was acceptably reliable for patient-started testing but not acceptable for examiner-started testing for the three muscles studied.

Caruso and Leisman[5,7] graphed displacement/force (dx/dF in inches/pound) over time, producing looping curves with clearly different shapes for muscles perceived by an experienced examiner as being strong or weak. The curves were less distinct for inexperienced examiners. The regression angle of the leading edge of this plot had angles ranging from 60 to 90 degrees (rightward slanting loops) for conditionally inhibited muscles and 0 to 59 degrees (narrow, nearly vertical loops) for conditionally facilitated muscles. These studies supported the contention that the subjective perceptions of facilitation (strength) or inhibition (weakness) by an experienced examiner correspond to objectively measurable differences in muscle states. The descriptions of muscle testing in these studies by Leisman, et al were all consistent with descriptions of examiner-started tests. Replication of these studies with clearly defined examiner-started and patient-started parameters will add valuable data to the questions under consideration in the present paper.

Nicholas et al[20] measured force over time and angular displacement of the limb, and found that the duration of the tester's effort multiplied by the average applied force during each test was the factor that most influenced the tester in ratings. However, it should be noted that this study evaluated ratings of strength deficits between limbs in those trials when the examiner could break the muscle contraction and excluded all tests where the examiner could not move the limb – those tests which would be rated as normal facilitation or grade 5. Perot, Meldener and Goubel[21] studied torque vs. surface electromyography (sEMG) from the examiner's triceps during testing of the tibialis anterior before and after a manual proprioceptive technique applied to the subject's muscle. Torque was measured from a footplate under the tested foot. The examiner was blinded to whether the proprioceptive technique had been applied or not. In addition to finding that the proprioceptive procedure did reduce muscular maximum voluntary contraction, they emphasized that proper coordination of examiner and subject effort was necessary to obtain reliable results.

The present study is intended to begin exploring the relationships of timing of examiner and subject muscle activation during MMT, comparing examiner-started and patient-started testing, and further to record the muscle testing of highly experienced AK muscle testers, including Goodheart, doing each form of muscle testing. The data collected from this and future studies will aid in standardization of terminology, training of practitioners and as a basis for further research.

The hypothesis of this study is that there is a definable difference in the timing of sEMG tracings of examiner and subject which can differentiate objectively between examiner-started and patient-started MMT.

METHODS

Subjects

Twenty-one volunteer doctors of chiropractic attending a conference participated in the study. 24 chiropractors and students served as subjects in the study. A researcher explained the procedures of the study to all participants. All doctors and subjects signed an informed consent form before participation in the study.

Both the examiners and subjects were invited to participate in the research project if they had no self-reported mental and physical disorders that would interfere with muscle testing. Participants over 21 years of age of both genders were accepted into the study. Any individual with self-reported coronary heart diseases, severe hypertension and physical ailments that would impede the manual muscle test were excluded from the study. Individuals who did not comply with the written informed consent form were also excluded from the study.

Manual Muscle Testing

All examiners and subjects were required to rest at least 5 minutes before testing. All tests were done with the subject in a comfortable seated position. Depending on the examiner's hand dominance and preference of testing position, the muscle testing was performed on the subject's left arm or right arm. The subject's testing arm was exposed for testing and attachment of EMG electrodes. The locations of EMG electrode attachment were selected based on the muscle activity during the testing movement. The testing examiners took a standing position.

The examining doctors were allowed to position the subjects as they preferred for testing the deltoid the way they would typically do a seated middle deltoid test in their practice. Examiners were first asked to test the muscle in the manner that they would commonly use in the routine of their office, delivering instructions to the subject as they would to a patient. The test was repeated 2 more times. The examiner was then asked to indicate whether he/she considered the muscle to be "weak" (functionally inhibited) or "strong" (functionally facilitated). The examiner was then asked whether he/she considered that the test was patient-started or examiner-started or other. The same examiner was then asked to perform the other style(s) of muscle testing. If the initial test was examiner-started, they were asked to perform a patient-started test on the same patient and vice versa. If the examiner answered that they did not normally differentiate whether their typical test procedure was examiner- or subject-started, or that examiner and subject contractions were simultaneous, the examiner was asked to perform a series of 3 examiner-started muscle tests, followed by a series of 3 subject-started muscle tests, after the "normally done" test. The same examiner tested 3 sequential subjects through all of the above steps in the same manner.

Each of the examining doctors tested the deltoid in essentially the same fashion, with the subject's shoulder abducted to 90 degrees, the elbow flexed to approximately 90 degrees with the forearm parallel to the floor and the force applied to the distal upper arm proximal to the flexed elbow. These parameters remained the same in each of the tests.

A typical examiner-started test was performed by the examiner pressing the subject's arm downward and asking the subject to resist the exerted force. A typical subject-started muscle test was done by asking the subject to raise his/her arm from the initial test position and the examiner resisting the exerted force. During the study session, a video camera was used to visually document the muscle testing from the examiners and the subjects.

Surface EMG

All sEMG recordings were conducted in a quiet hotel conference room. Five minutes of rest were given before each sEMG data collection. Two EMG modules were used in the tests, one for the examiner and one for the subject. Both EMG modules were recorded at the same time. Disposable electrodes (silver/silver chloride) were used for all bipolar EMG measurements. For the subjects, the positive electrode was placed on the anterior deltoid muscle, the negative electrode was attached to the posterior deltoid muscle and the ground electrode was placed on the forearm of the arm being tested. For the examiner, the positive electrode was placed on the upper wrist flexor, the negative electrode was attached to the lower wrist flexor and the ground electrode was placed on the wrist of the testing arm. EMG recording and electrode attachment were according to methods described by Colloca and Keller.[22] The data consisted of 3 minutes of recording of sEMG. The time of data recording allowed the examiner and the subject to perform the 3 repetitions of the examiner- and subject-started testing and the pressure transducer tests. Each examiner was asked to perform the same tests on three subjects.

MP 100 amplifiers (model MP100; Biopac Systems, Inc., Santa Barbara, CA) were used for EMG amplification. The EMG signal was sampled at 200/sec. All data from the laboratory study were digitized by a Biopac 16-bit digitizer and software system. Tracings were analyzed visually for the starting time of examiner and subject sEMG signal during the test, using the time marking feature of the Biopac software.

Statistical analysis

The beginning of the muscle contraction for subject and examiner were marked on one of the 3 tracings for each examiner/subject pair for each type of testing. This was the second tracing, unless baseline noise made determination of a starting point difficult, in which case the third or first tracing was marked. Continuous data were expressed as mean ± SD. One-way analysis of variance was used for comparisons of continuous variables. A probability level of <0.05 was considered statistically significant.

RESULTS

Type of Testing Normally Done

Each examiner was first instructed to test the subject in the way in which he or she normally performs manual muscle tests and asked to identify what type of testing was used. Nine examiners (43%) identified their usual muscle test as examiner-started. Four examiners (19%) identified their normal testing as patient-started. Eight examiners (38%) identified their normal test as simultaneous or said that they do not differentiate in that manner. Of these, 2 gave mixed answers; one did not recognize the 2 styles of muscle testing and made contradictory statements several times.

Start Time Differences and Congruence

When the examiner identified his testing as examiner-started, the examiner's contraction actually began first 64.5% of the time. When the examiner identified his testing as patient-started, the patient's contraction began first 54% of the time. In undifferentiated/simultaneous testing, the patient started first approximately 45% of the time and the examiner started first approximately 45% of the time and was exactly simultaneous 10% of the time. Examiner-started tests were exactly simultaneous 8% of the time and patient-started tests were exactly simultaneous 4.7% of the time.

For over 50% of both examiner- and patient-started testing, both contractions began within 75 milliseconds of each other. For undifferentiated/simultaneous testing, both contractions started within 75 millisecond 70% of the time.

The mean difference between patient and examiner start times for all measured tests was 26 ms (examiner-started direction). The mean for examiner-started tests was 75 ms, 25 ms for patient started (patient-started direction), and for undifferentiated/simultaneous testing was 39 ms (Table 1).

Table 1
Subject—Examiner Start Time Difference (Seconds)

	Count	Mean	Standard deviation	Minimum	Maximum
ES	62	0.075	0.232	−0.645	1.115
PS	63	−0.025	0.231	−0.94	0.78
DD	20	0.039	0.158	−0.16	0.565
All	145	0.026	0.226	−0.94	1.115

ES = examiner-started, PS = patient-started, DD = tests not differentiated or labeled as simultaneous, All = all combined.

Table 3
Fisher's PLSD for Subject-Examiner Start-Time Differences by Style

	Mean difference	Critical difference	P Value	Significance
ES, PS	.100	.079	.0137	S
ES, DD	.036	.113	.5369	
PS, DD	−.064	.113	.2650	

ES = examiner-started, PS = patient-started, DD = tests not differentiated or labeled as simultaneous.

Statistics

ANOVA comparison and Fischer's PLSD tests of mean start-time differences between the 3 groups demonstrated a statistically significant difference between examiner started and patient started testing (P = 0.0137). No statistically significant difference was found between either examiner started or patient started and undifferentiated testing (Tables 2 and 3). There is extensive overlap in start-time differences between all styles of testing, so this difference in means alone does not allow separation of the tests done into clearly distinct styles objectively (Figs 1–4).

Goodheart Tracings

As the founder of AK, Dr. George Goodheart serves as a form of a "gold standard" for AK muscle testing. He is frequently cited by AK authors as the model for their recommended testing style. For illustrative purposes, and in answer to the claims and counterclaims about his testing, we objectively recorded what Dr. Goodheart actually does when he performs muscle tests. Figures 5–10 illustrate a representative set of the sEMG tracings of Dr. Goodheart's testing for one subject. These tracings are the second of each set of 3 on the first subject tested by Goodheart. His "normal" test is near simultaneous, as he stated.

DISCUSSION

While many MMT practitioners consider that they are performing either an examiner- or patient-started muscle test, it appears from this study that a significant proportion of practitioners do not explicitly make this distinction routinely. Examiners are not always accurate in identifying the actual style of test which they are performing. This is not entirely surprising, as the time differences in many instances are quite small. All tests clustered rather closely around 0 difference in start time between examiner and subject contractions. There was extensive overlap between labeled testing styles. Contrary to Gerz's theory, there was no evidence that examiner-started testing as performed by these examiners failed to provide the patient an adequate time to appropriately respond to the muscle test.

Dr. Goodheart identified his "normally" done test as simultaneous contraction of the patient and examiner, although in that the examiner was directing the test, it was to that degree and by definition an examiner-initiated MMT. This nuance in response may account for some of the varying assertions about Dr. Goodheart's testing, which are used to support opposing opinions about appropriate MMT.

The existence and prevalence of a near-simultaneous style of testing was not predicted although it was expected that some testers would not differentiate their testing as examiner-started or patient-started MMT. We hypothesized that these unlabeled tests would be demonstrated to be clearly examiner started or clearly patient started. It turned out to be evenly divided, with more exactly simultaneous starts than in the other forms of testing. Undifferentiated testing over all tended to be closer

Table 2
ANOVA Table for Subject-Examiner Start-Time Differences Split by Style

	DF	Sum of squares	Mean square	F-Value	P-Value	Lambda	Power
Style	2	.314	.157	3.151	.0458	6.302	.589
Residual	142	7.068	.050				

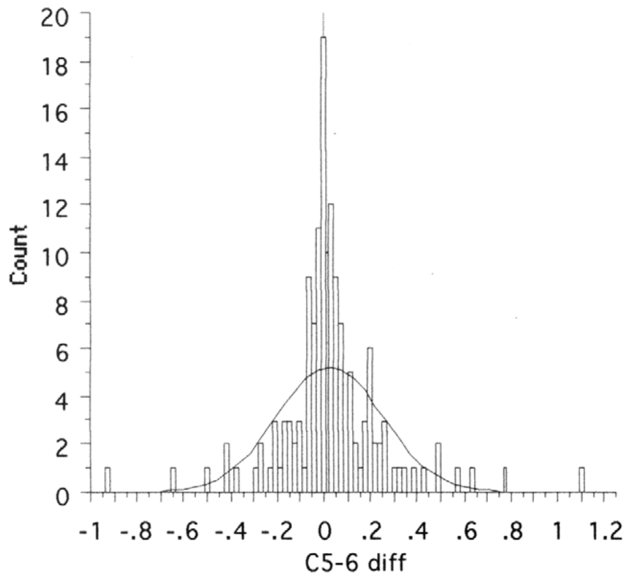

Figure 1. All tests: Differences in sEMG starting times between subject and examiner (seconds). Negative = patient-started; positive = examiner-started.

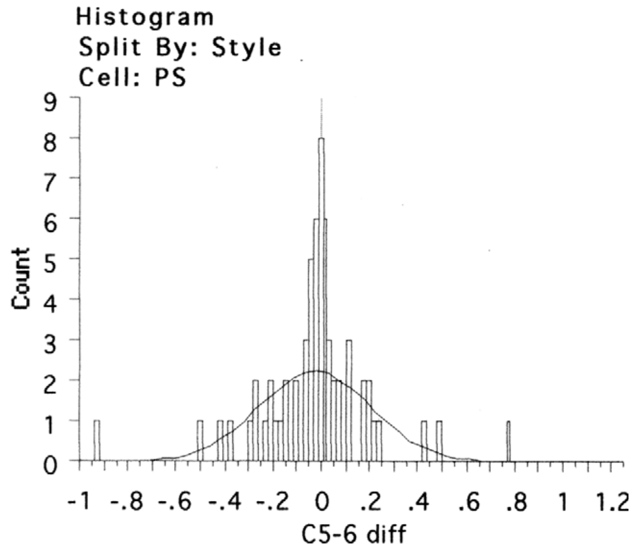

Figure 3. Patient-started tests: Difference in sEMG starting times between subject and examiner (seconds). Negative = patient-started; positive = examiner-started.

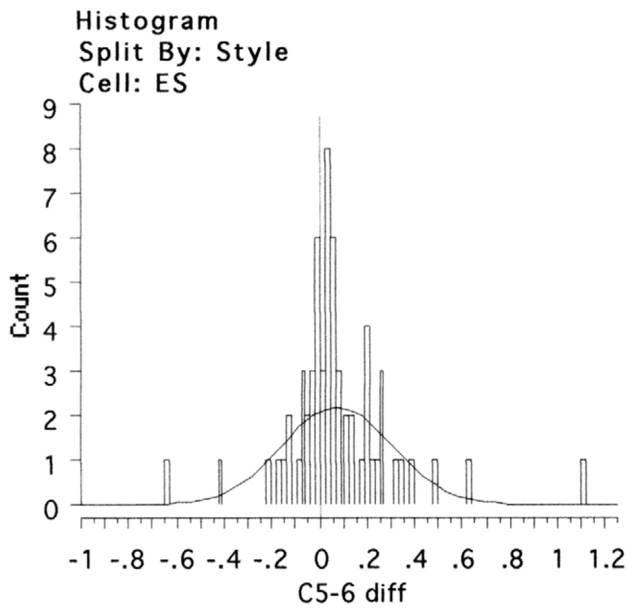

Figure 2. Examiner-started tests: Difference in sEMG starting times between subject and examiner (seconds). Negative = patient-started; positive = examiner-started.

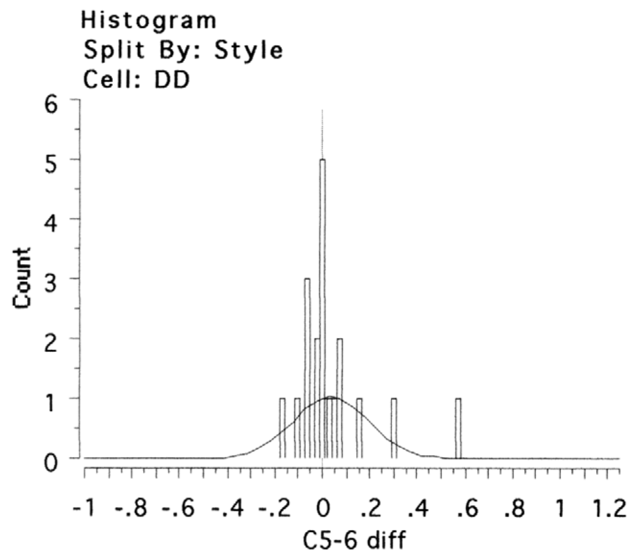

Figure 4. Undifferentiated tests: Difference in sEMG starting times between subject and examiner (seconds). Negative = patient-started; positive = examiner-started.

to simultaneous than either of the other styles, as evidenced by a smaller standard deviation.

What is most striking when marking a large number of sEMG tracings is the responsiveness of the subject and examiner to each other. A subtle change in one tracing is almost always reflected in a corresponding, virtually simultaneous change in the other, throughout the whole sEMG tracing. AK muscle testing as performed by these examiners is a delicate interplay and response between examiner and subject contractions. It is possible that failures or lags in the subject's fine responses to the gradually changing pressure of the muscle test prevent the subject

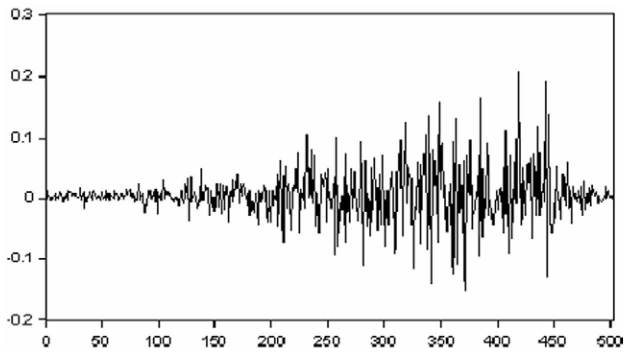

Figure 5. Dr. Goodheart Typical MMT, simultaneous MMT subject tracing, subject 1.

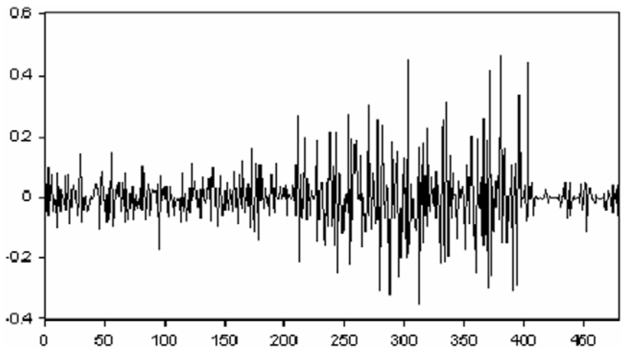

Figure 6. Dr. Goodheart Typical MMT, simultaneous MMT examiner tracing, subject 1.

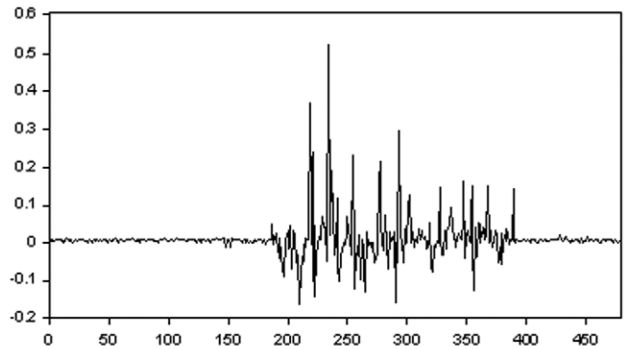

Figure 7. Dr. Goodheart examiner-started MMT, subject tracing, subject 1.

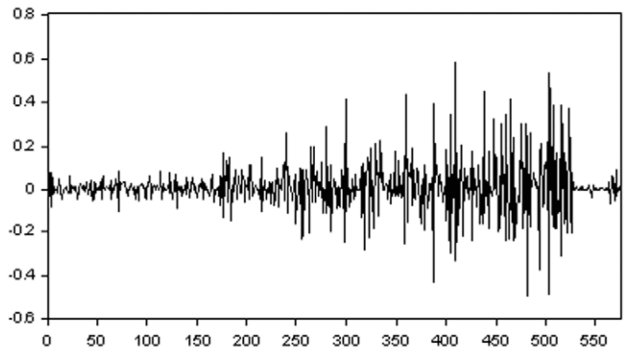

Figure 8. Dr. Goodheart examiner-started MMT, examiner tracing, subject 1.

from being able to maintain the test position and this is what the examiner perceives and identifies as functional inhibition or "weakness."

All examiners and subjects were familiar with MMT. This might be seen to be a source of potential bias. However, after their first encounter, all patients in a clinical situation have become familiarized with the muscle testing used by their doctor, and so this study did approximate what could be expected with an experienced examiner and an experienced patient, the most common situation in which this type of muscle testing is used. A similar study could be done with naïve versus experienced subjects to specifically examine this question.

A potential weakness in this study was that all examiners were asked to do both examiner-started and patient-started MMT, whether or not they commonly did these forms of testing. For examiners who normally do not differentiate between these forms of testing or use only one of them, trying to do an unfamiliar form of testing may have given atypical results. This study included very few examiners from outside of the United Stated and it is possible that more differences in testing style would be evident with a larger and more diverse group of examiners.

Before claims about the meaning of different styles of testing can be tested, objective distinctions need to be established. It is possible that different neurological mechanisms are indeed engaged in examiner-or patient-started testing where there is a relatively large difference in start times, as compared to the more common near-simultaneous testing, regardless of how it is labeled. Testing this hypothesis would require training so that examiners could execute a muscle test repeatedly within the designated parameters, perhaps using sEMG monitoring similar to that used in this study.

Future research should record the force applied simultaneous with the sEMG to compare the starting point of the force in relationship to the subject and examiner sEMG tracings and to track forces over

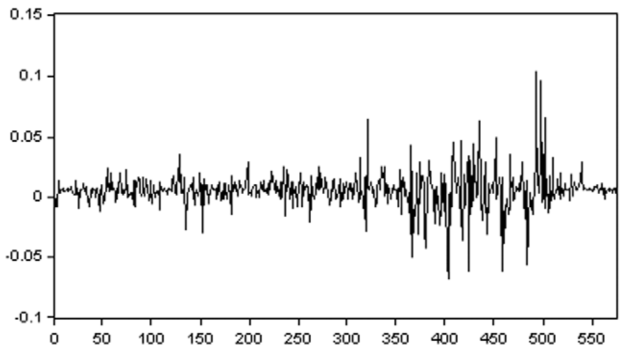

Figure 9. Dr. Goodheart patient-started MMT, subject tracing, subject 1.

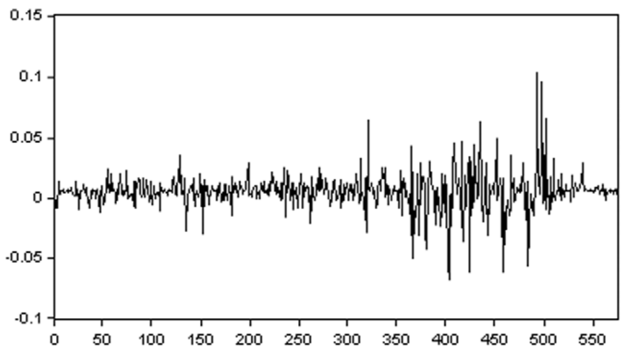

Figure 10. Dr. Goodheart patient-started MMT, examiner tracing, subject 1.

time. Parameters to examine include speed of application of force (slope and contour of the force curve), duration of force and whether force increases stepwise during the duration of the test, as postulated in Schmitt's original description of MMT. Replication of the Caruso and Leisman force-displacement plots and angles would be useful. Nicholas' force times duration of test measure should also be examined to determine whether any patterns of force application can be correlated with perception of inhibition vs. facilitation or correlated with differences of test outcome between examiners for the same patient on AK testing as opposed to the break testing as done by Nicholas. Vasilyeva et al[23] have studied sEMG data during AK muscle testing with a variety of provocative stimuli during 9-second muscle tests, seeing sEMG differences between the three 3-second segments of each test. These tests were much longer duration tests than the ones performed in the present study or in routine clinical use. It would be useful to determine whether the duration of force affects test outcomes in tests done as experienced AK examiners normally do them. Intra-examiner consistency of timing and force should also be researched in more detail. Investigations should be replicated in other muscles.

CONCLUSIONS

While some examiners vary technique enough to create a measurable difference between examiner- and patient-started testing, the majority of AK testers in this study actually do near-simultaneous testing, regardless of the label they use. In undifferentiated/simultaneous testing, contractions by examiner and patient tend to be closer to simultaneous than in testing where the examiners consciously attempted to perform a patient-started or examiner-started test.

This study was unable to establish objective sEMG parameters to clearly distinguish between putative examiner- and patient-started forms of MMT. Examiners are only slightly better than chance at labeling the style of their testing. Regardless of label, the baseline, most commonly used AK muscle test in this group is near simultaneous, within 75 ms. If physiological or clinical differences are to be determined for muscle tests with different timings, either to the examiner- or patient-started side, there must be a clear definition of the cut-off point where those differences become meaningful. If such differences are defined and demonstrated, then examiners need to be trained to consistently perform the style of testing intended. Until this is done, statements about the style of MMT performed and its clinical significance should be viewed as hypothetical.

ACKNOWLEDGEMENTS

The authors thank Dr. Richard Meldener for input on research design, the Logan College of Chiropractic for the use of sEMG and BioPac equipment, and Dr. Gary Sanders for consultation on statistical analysis.

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