Forensic Applications and Levels of Validity in Manual vs. Computerized Muscle Testing

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Introduction

It was once said that the medical establishment (and in this case I would include the grand old profession of chiropractic) has the enviable facility of swallowing their own propaganda. This editorial and case report is my own story. Yes, I must admit that in my early years of practice I eschewed high-tech diagnostic equipment, as some who heard me lecture in the late 1980s or early 1990s will remember. Muscle testing, I argued then, requires only a trained and sensitive examiner. Range of motion required only a good goniometer. It seems many of us have engaged in a form of suspended disbelief, something that has a place in Hollywood but not healthcare. However, times have changed. In a medicolegal practice today, experts are pitted against experts in a battle of both wits and evidence and their opinions are weighted on the basis of their validity. My approach to forensic practice is very different today than it was in decades past. This article highlights some of that journey.

The History of Manual Muscle Testing

Injury and disease can produce muscle weakness that is irreversible. Depending on the individual's work and lifestyle, and the degree of weakness, this deficit may constitute some level of impairment. The AMA's *Guides to the Evaluation of Permanent Impairment* relies in part on clinicians' assessment of muscle strength loss in the determination of impairment (1). The unstated (and too often unquestioned) assumption in such endeavors is that a fair degree of reliability exists. This reliability can be measured in a number of ways, but in plain English, we should ask, for example: If three different clinicians manually muscle-tested an individual who consistently put forth an honest maximal effort, would they agree with each other in their assessments? How much variance would there be? Would that degree of variance be acceptable given the fact that fairly important decisions concerning a person's permanent impairment, employability, future earning capacity, psychosocial factors, insurability, and even their ability to file future claims might rest on the outcome of such testing? Even if suitable inter-rater reliability exists, we should then ask how sensitive manual muscle testing (MMT) is in the experts' hands. In other words, even if they all manage to agree with each other, are they all correct to an important degree? Can experienced clinicians, for example, detect as little as a 10% side-to-side variation in muscle strength in a patient? Finally, we should ask whether all clinicians have suitable physical strength to evaluate all muscle groups of patients effectively. For example, can a very elderly practitioner or one who is very small and not terribly strong effectively test the quadriceps or biceps muscles of large, muscular individuals?

Traditionally, practitioners rely on MMT to guide them in ordering special tests, in measuring recovery, and in gauging permanent impairment. Yet in recent times, it has been demonstrated that the reliability and sensitivity to MMT is woefully low and perhaps even unacceptable (2). My friend, Alex Ambroz, sent me a prerelease copy of his paper and it inspired me to work on this paper.

In their review, Ambroz et al. note how MMT has been shown to be an unreliable method for assessing strength in several clinical studies. In one, skilled examiners performing MMT often rated strength as normal in patients who had as much as 50% strength loss, as measured by quantitative testing. In another, when strength loss was less than 50% it was not detectable. In a third, inter-rater reliability across four muscles tested by a group of physical therapists in 110 subjects varied from 28% to 47%. This is no minor cavil. These studies argue that our clinical yardsticks are elastic and inadequately calibrated; that our methodology is only marginally superior to a hunch. This may not be so surprising considering this method originated with Hippocrates, but it suggests that MMT should probably be relegated to the arcana of medical procedures once and for all.

What might be the problem? As Ambroz et al. point out, some examiners use "make" tests while others use "break" tests. The former is one in which the muscle is tested with the subject being told to push against the examiner's resistance. In the latter, the examiner tells the patient to resist his/her efforts and tries to overpower the subject, taking note of the amount of force required to do that. Variations in technique and stabilization method can be critical sources of variation as well. And then there is the question of the examiner's physical strength. There are some men who have such strength in their biceps muscle that smaller, less physically robust examiners would be hard pressed to break their strength even if they had a 15-20% strength loss. This may be true of many muscle groups. The lack of precision is comparable to measuring range of motion using the popular eyeball method rather than with dual inclinometers. And I should also mention examiner bias. This has nothing to do with precision but concerns conscious or unconscious expectation and/or desire to either find a loss or not find a loss.

My Case

Because this is an ongoing case, I will describe him in only general terms. He injured his neck and low back several years ago in a motor vehicle collision and is now claiming to be 100% disabled. He is neurologically intact, with not much more than an odd sensory pattern, has no apparent or measurable atrophy, and has very exquisite tenderness to palpation over his entire spine, although most of his pain these days is in the lumbar midline. He also has a very high level of muscle tone paraspinally. He is middle aged, tall (6 ft 3 in), and of medium build (180 lb). He has also been examined by experts from at least three countries. There is, so far, only marginal agreement that he has "chronic pain syndrome." He's had MRIs of his neck and low back, both of which are normal. His needle EMG study was also normal.

When I examined him I decided to look in places no other experts had explored, so I used computerized isotonic dynamometry (CID) to test multiple muscle groups of both upper and lower extremities. Unlike MMT, CID has been demonstrated to have fairly good reliability (3-6). It can detect side-to-side variations of as little as 10% reliably and uses a coefficient of variation statistic to assess the effort of the subject. It also provides a graphical time-force history which allows clinicians to assess the morphology of the resulting repeated measures curves and rule out cogwheeling or other evidence of insincere effort. Figures 1 and 2 demonstrate the computer screen results and the graphical results of one of the upper extremity tests. It is an exemplar of the other tests. Clearly, there is no evidence of malingering. What was most interesting was that this right dominant side loss of strength was found in nearly every muscle group at an average level of loss of 34%. In no case was strength loss found on the left side and equal strength was found in a couple of groups. Thus, we have a rather striking example of right-sided hemiparesis that was discovered for the first time using a new technology. I would estimate that the reasons for this are (a) nobody has really performed even a careful MMT, much less CID and (b) this is a fairly strong man and strength loss even of 35% would be very difficult to gauge with MMT.

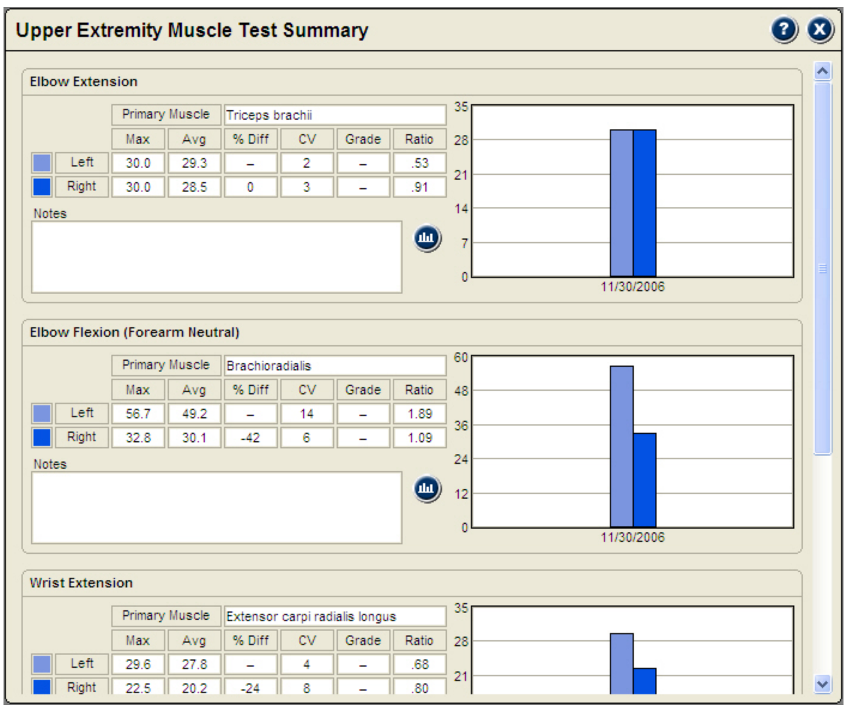

Figure 1. Screen of computerized isotonic dynamometer test of elbow extension (normal) and flexion (demonstrating a weakness on the dominant side) with a CV falling within acceptable ranges indicating a valid effort on the part of the patient.

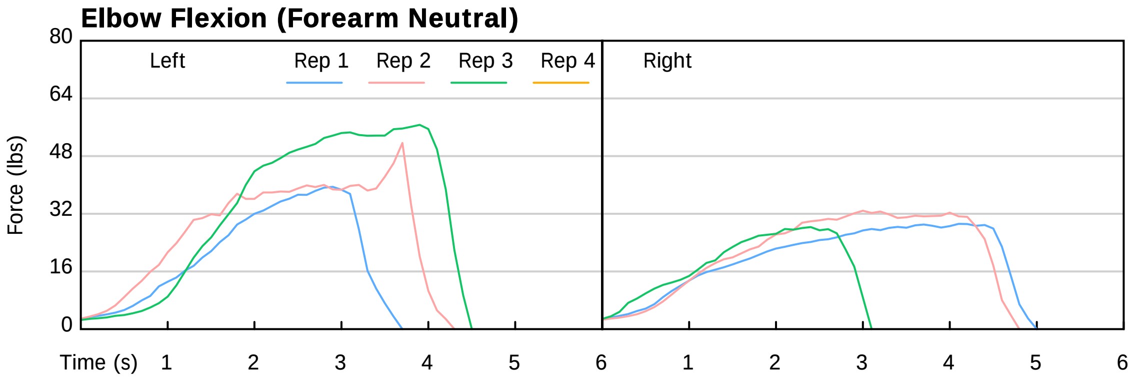

Figure 2. Force-time curve of repeated measures computerized isometric dynamometry of elbow flexion indicates a consistent pattern of weakness in the right, dominant arm, with an absence of cogwheeling, consistent with a valid effort by the patient (tests and images obtained using JTECH Medical, Salt Lake City, UT).

Range of Motion (ROM) can also be measured with the same level of precision and reliability. In this case it is measured and recorded using dual wireless fully calibrated inclinometers with a very high level of precision (JTECH Tracker™ from JTECH Medical, Salt Lake City, UT). This is also a repeated measures analysis with the reliability of the patient's effort measured statistically for optimum reliability and validity. The measured ranges are then input into graphing software (*Harvard Chart XL*) programmed with normative rage of motion data based on age and sex (our proprietary software), and percentages of expected normal range are then automatically plotted against the actual range and percentage of deficits Figure 3.

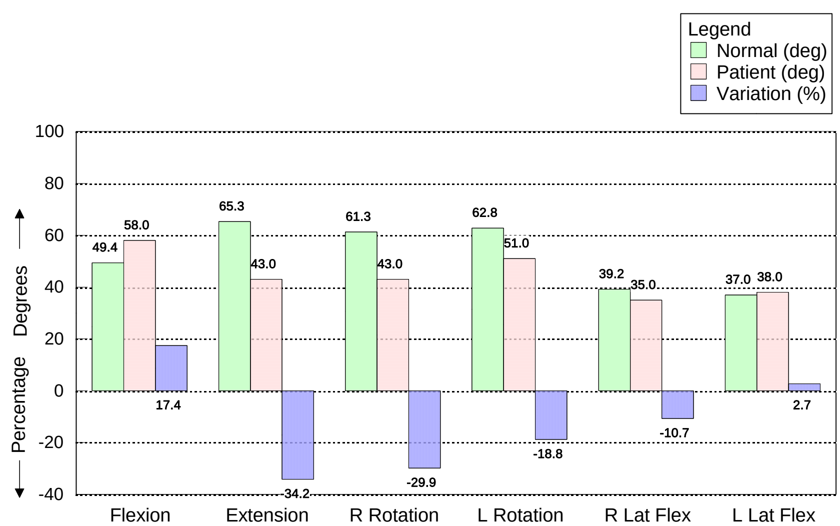

Figure 3. Age- and gender-normalized expected vs. actual cervical ROMs in the 6 standard degrees of freedom, with loss plotted as percent variation. Significant limitations are noted in extension, right rotation, and left rotation.

Dynamic surface electromyography (sEMG) allows clinicians to assess the electrical signal coming from muscles, similar to the way an EKG records the electrical signal of a beating heart or an EEG records the electrical signal from an active brain. This technology allows clinicians to differentiate normal from abnormal signals in the majority of cases. For example, abnormal signals have been demonstrated to distinguish between individuals suffering from whiplash injury and healthy controls (7-10). Surface EMG has become well established for its sensitivity to muscle activation (11) and as a diagnostic and outcome measure in whiplash research (12-18), and as one poised to become the standard for determining the validity of claims in the near future (19). Once the skin is prepped with vigorous rubbing and alcohol swab, pre-gelled Ag/AgCl electrodes are applied over paraspinal and (in the case of the neck) SCM muscles and recordings are made as the patient moves through directed arcs of motion. Although the subject is quite complex, Figures 4 and 5 demonstrate one of the several objective patterns of abnormality that can be revealed using this new technology.

[Note that sEMG is a different technology than needle EMG and the two have different clinical uses. While sEMG can objectify certain types of chronic pain because abnormal patterns are not found in normal paraspinal muscles and because they cannot be faked, it does not provide a diagnosis per se. Needle EMG is used to evaluate the motor peripheral nervous system and attempts to determine the health of specific nerves or nerve roots indirectly.]

In this patient's case, significant abnormalities were found in both the cervical (Figure 5) and lumbar spine (not illustrated). While these abnormalities do not allow us to make a specific diagnosis, they do allow us to differentiate a normal pattern from an abnormal pattern.

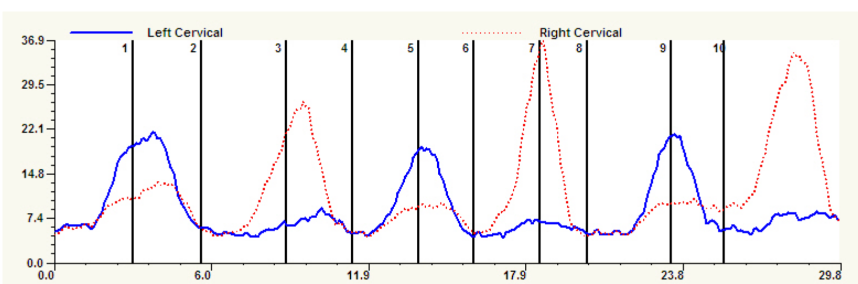

Figure 4. A normal dynamic sEMG tracing of cervical lateral flexion. The red dashed line is the electrical signal generated by the right paraspinal musculature and the blue solid line is the signal from the left paraspinal muscles. When the patient bends to the left, the ipsilateral paraspinal muscle activity increases, while that of the right is relatively silent and vice versa. [Image recorded using a 4-channel signal acquisition system with Ag/AgCl gel electrodes (Precision Biometrics/Myovision, San Carlos, CA)].

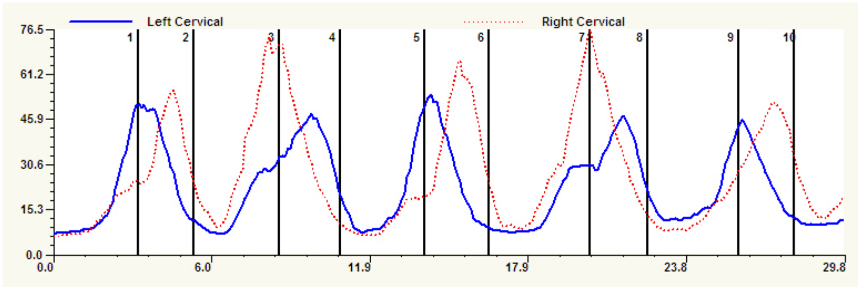

Figure 5. In contrast to Figure 4, there is very little relaxation of opposite paraspinal muscle activity. This is a subject with chronic neck pain resulting from whiplash injury. [Image recorded using a 4-channel signal acquisition system with Ag/AgCl gel electrodes (Precision Biometrics/Myovision, San Carlos, CA)].

This case is still in active litigation and it is difficult to predict which way it will go. But I am confident that, coupled with my physical examination, the medical records, mechanism of injury, and other findings, these new technologies represent the new high water mark in diagnostics and will provide a much stronger foundation from which to proceed.

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