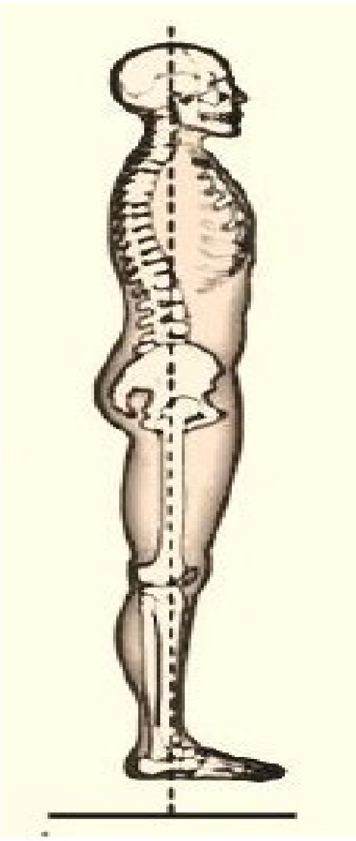
MUSCLES

TESTING AND FUNCTION WITH POSTURE AND PAIN



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1

Fundamental Concepts

INTRODUCTION

The underlying philosophy of this book is that there is a continuing need to “get back to basics.” This philosophy is especially pertinent in this era of time-limited treatments and advancing technology.

Muscle function, body mechanism, and simple treatment procedures do not change. With respect to musculoskeletal problems, the underlying purposes of treatment have been, and continue to be, to restore and maintain appropriate range of motion, good alignment and muscle balance.

It is essential that the practitioner choose and effectively perform tests that aid in solving problems, whether to provide a differential diagnosis, treatment procedures, improve function, or relieve pain. Of paramount importance, for students and clinicians, is the ability to think critically, to demand objectivity, and to use the caution and care needed for appropriate, accurate and meaningful tests and measurements.

The role of prevention of musculoskeletal problems is destined to become an increasingly important issue in the future. Health practitioners can play an effective role in promoting wellness if they are aware of effects of the muscle imbalance, faulty alignment, and improper exercise.

A through understanding of muscle problems and painful conditions associated with poor posture will enable practitioners to develop safe and effective home programs for their patients. The cost to society for treatment of common problems, such as low back pain are related to faulty posture and corrected or alleviated by restoring good alignment.

The timeless importance of effective musculoskeletal testing is evident in the last segment of Chapter 1. The unique presentation of muscle test results for a post polio patient over a fifty year period demonstrates the durability of testing and grading.

MANUEL MUSCLE TESTING

This book emphasizes muscle balance and the effects of imbalance, weakness, and contracture on alignment and function. It presents the underlying principles involved in

preserving muscle testing as an art, and the precision in testing necessary to preserve it as a science.

The art of muscle testing involves the care with which an injured part is handled, the positioning to avoid discomfort or pain, the gentleness required in testing very weak muscles, and, the ability to apply pressure or resistance in a manner that permits the subject to exert the optimal response.

Science demands rigorous attention to every detail that might affect the accuracy of muscle testing. Failure to take into account apparently insignificant factors may alter test results. Findings are useful only if they are accurate. Inaccurate test results mislead and confuse and may lead to a misdiagnosis with serious consequences. Muscle testing is a procedure that depends on the knowledge, skill, and experience of the examiner who should not betray, through carelessness or the lack of skill, the confidence that others rightfully place in this procedure.

Muscle testing is an integral part of physical examination. It provides information, not obtained by other procedures, that is useful in differential diagnosis, prognosis and treatment of neuromuscular and musculoskeletal disorders.

Many neuromuscular conditions are characterized by muscle weakness. Some show definite patterns of muscle involvement; others show spotty weakness without any apparent patterns. In some cases, weakness is symmetrical, in others, asymmetrical. The site or level of peripheral lesion may be determined because the muscle distal to the site of the lesion will show weakness or paralysis. Careful testing and accurate recording of test results will reveal the characteristic findings and aid in diagnosis.

Musculoskeletal conditions frequently show patterns of muscle imbalance. Some patterns are associated with handedness, some with habitually poor posture. Muscle imbalance may also result from occupational or recreational activities in which there is persistent use of certain muscles without adequate exercise of opposing muscles. İmbalance that affects body alignment is an important factor in many painful postural conditions. The technique of manual muscle testing is basically the same for cases of faulty posture as for neuromuscular conditions, but the range of weakness encountered in faulty posture is less because grades below fair are uncommon. The number of test used in cases of faulty posture is also less.

Muscle imbalance distorts alignment and sets the stage for undue stress and strain on joints, ligaments, and muscle. Manuel muscle testing is the tool of choice to determine the extent of imbalance.

Examination to determine muscle length and strength is essential before prescribing therapeutic exercise because most of these exercises are designed either to stretch short muscles or to strength weak muscles.

Muscle length testing is used to determine whether the muscle length is limited or excessive, i.e., whether the stretched and allowing too much of range of motion. When stretching is indicate, tight muscles should be stretched in a manner that is not injurious to part or to the body as a whole. Range of motion should be increased to permit normal joint function unless restriction of motion is a desired and result for the sake of stability.

Muscle strength testing is used to determine the capability of muscles or muscle groups to function in movement and their ability to provide stability and support.

Many factors are involved in the problems of weakness and return of strength. Weakness may be due to nerve involvement, disuse atrophy, stretch weakness, pain, or

fatigue. Return of muscle strength may be due to recovery following the disease process, return of nerve impulse, after trauma and repair, hypertrophy of unaffected muscle fibers, muscular development resulting from exercises to overcome disuse atrophy, or return of strength after stretch and strain have been relieved.

Muscle weakness should be treated in accordance with the basic cause of weakness. If due to lack of use, then exercise; if due to overwork and fatigue, then rest; strain before the stress of additional exercise is thrust upon the weak muscle.

Every muscle is a prime mover in some specific action. No two muscle in the body have exactly the same function. When any one muscle is paralyzed , stability of the part is impaired, or some exact movement is lost. Some of the most dramatic evidence of muscle function comes from observing the effects of loss of the ability to contract as seen in paralyzed muscles, or the effect of excessive shortening as seen in a muscle contracture and the resultant deformity. The muscle testing described in this book is directed towards examination of individual muscles insofar as is practical. The overlap of muscle actions, as well as the interdependence of muscles in movement, is well recognized

by those involved in muscle testing. Because of this close relationships in functions, accurate testing of individual muscles requires strict adherence to the fundamental principles of muscle strength testing and rules of procedure.

Fundamental components of manual muscle testing are test performance and evaluation of muscle strength and length. To become proficient in these procedures one must possess a comprehensive and detailed knowledge of muscle function. This knowledge must include an understanding of joint motion because length and strength tests are described in terms of joint movements and positions. It must also include knowledge of agonistic and antagonistic actions of muscles and their role in fixation and in substitution. In addition, it requires the ability to palpate the muscle or its tendon, to distinguish between normal and atrophied contour, and to recognize abnormalities of position or movement.

One who possess a comprehensive knowledge of the action of muscles and joints can learn the techniques necessary to perform the tests. Experience is necessary to detect the substitution movements that occur whenever weakness exits; and practice is necessary to acquire skill for

performing length and strength tests, and for accurately grading muscle strength.

This book emphasized the need to “get back to basics” in the study of body structure and function. For musculoskeletal problems, accomplishing this entails a review of the anatomy and function of joint, and of the origins, insertions and action of muscles. It includes an understanding of the fundamental principles upon which evaluation and treatment procedures are based.

As a textbook, it stresses the importance of muscle tests, postural examinations, assessment of objective findings, musculoskeletal evaluation, and treatment. In a condition that is primarily musculoskeletal, the evaluation may constitute and determine a diagnosis. In a condition not primarily musculoskeletal, the evaluation may contribute to a diagnosis.

OBJECTIVITY AND REABILITY IN MUSCLE TESTING

There is increasing demand for objectivity regarding muscle testing measurements. With the high cost of medical care, the economics of reimbursement requires documentation that improvement has resulted from

treatment. There is a demand for numbers as proof. The more gradual the improvement, the more important the numbers become so that even minimal changes can be documented.

Many advocate the use of instrumentation to eliminate the subjective component manual muscle tests. Several questions, however, have not yet been adequately answered. To what extent can the subjectivity inherent in manual muscle testing be eliminated using instrumentation? How do new problems and variables introduced by instruments affect the accuracy, reliability and validity of the muscle test?

The value of objective measurements obtained through use of present-day machines must be weighed against their limited usefulness, cost and complexity.

Length tests, if performed with precision, can provide objective data through use of simple devices such as goniometers to measure angles, and rulers or tape measurement to measure distance.

Strength tests cannot rely on such simple devices. The problems are very difference when measuring strength. Objectivity is based on the examiner's ability to palpate and

observe the tendon or muscle response in very weak muscle, and to observe the capability of a muscle to move a part through partial or full range of motion in the horizontal plane, or to hold the part in an antigravity position.

Visual evidence of objectivity extends to an observer as well as to the examiner. An observer can see a tendon that becomes prominent (i.e., a trace grade), movement of the part in the horizontal plane (i.e., a poor grade), and a part being held in a antigravity position (i.e., a fair grade). Even the fair + grade, which is based on holding antigravity position against slight pressure by the examiner, is easy to identify. For these grades of strength, mechanical devices are not applicable or necessary as aids to obtain objectively.

The grades of strength that remain are the good and normal grades, as identified in manual muscle testing. In addition, a wide of strength is measured above the grade of normal. To the extent that determining the higher potentials of muscle strength is necessary, useful, and cost-effective, machines may play a role.

Under controlled research conditions, isokinetic machines can help in obtaining valuable information. At present, however, their usefulness in the clinic is limited. Problems

occur both in testing muscle strength and in exercising. One problem with machines is providing adequate stabilization of testing technique. Tests by machines lack specificity and substitution occurs. In addition to the high cost of machines, setting up patients is time-consuming; both are important factors when considering cost-effectiveness of the testing procedures.

It is generally agreed that tests done by the same examiner are the most reliable. Interestingly, the same holds true for numerous testing devices that have no subjective component. For example, many institutions require that successive bone-density scans always be done on the same machine. Too much variability occurs between similar machines to accurately track an individual's progress. Different machines of the same make and model are unable to provide reliable and comparable results. Even on the same machine an accuracy variant of up to or more than %3 can be found (Dr. David Zackson, personal communication, 2004).

Electromyography (EMG) is another important research tool, but its usefulness in muscle strength testing is questionable. According to Gregory Rash, "EMG data

cannot tell us how strong the muscle is, if one muscle is stronger than another muscle, if the contraction is a concentric and eccentric contraction, or if the activity is under voluntary control by the individual" (1).

The search continues for a suitable handheld device that can provide objective data regarding the amount of force that is used during manual muscle strength testing. The problem with a handheld device is that it comes between the examiner and the part of being tested. It also interferes with use of the examiner's hand. The examiner's hand must not be encumbered for positioning the part, for controlling the specific direction of pressure, and for applying pressure with the fingers, palm or whole hand as needed. (someday, there may be a glove that is sensitive enough to register pressure without interfering with the use of the hand).

Handheld devices measure the amount of force exerted manually by the examiner. They are not suitable for measuring the higher levels of maximum effort by the subject. With many difference types of dynamometers on the market, it is almost impossible to standardize tests or to establish the reliability of tests. The introduction of new and "better" devices further complicates and compromises all

previous testing procedures. The statement by Alvin Toffler that "under today's competitive conditions, the rate of produce innovation is so swift that almost before one product is launched the next generation of better one appears" may well apply to this as well as other fields (2).

A review of the literature regarding dynamometers reveals some of the problems associated with the use of these devices. A study of intertester reliability concluded that "the handheld dynamometer shows limited reliability when used by two or more testers" (3). Two studies have demonstrated good intratester reliability using handheld dynamometers (4,5). However, "hand-held dynamometers… may underestimate a patient' true maximal isometric strength, due to difficulties in stabilization of the device" (6).

Examiner strength presents another variable in handheld dynamometer reliabilities. Work by Marino et al. identified examiner strength as the reason for discrepancy between two examiners testing hip abductor strength (7). The examiner's strength affects the stability of the handheld dynamometer when used with stronger subjects (5). This problem was also related to gender differences by Mulroy et. The subject's maximal knee extension force, measured

by a handheld dynamometer, was accurate only for the male examiner testing female patients (8).

It is evident that the variety of devices used and the many variables involved preclude the establishment of norms for muscle grading. According to Jules Rothstein, "there may be a danger that fascination with new technology will lead to the clouding of sound clinical judgement" (9).

After a decade of scientific review, Newton and Waddell concluded that the "judgment of clinician appears to be more accurate in determining effort of the patient, than evaluating the results from the machines" (10).

As tools, our hands are the most sensitive, finetuned instruments available. One hand of the examiner positions and stabilizes the part adjacent to the part being tested. The other hand determines the pain-free range of motion, guides the tested part into precise test position, and gives the appropriate amount of pressure to determine strength. All the while, this instrument we call the hand is hooked up to the most marvelous computer ever created- the human mind- which can store valuable and useful information on the basis of which judgements about evaluation and treatment can be made. Such information contains

objective data that are obtained without sacrificing the art and science of manual muscle testing to the demand for objectivity.

CLASSIC KENDALL

One of the unique features of this text is the preservation of more than half a century of postural analyses and careful evaluation of muscle balance as it relates to function and pain. Many of the photographs provide outstanding historic examples of postural faults that are genuine rather than posed.

It is essential that every practitioner develop effective problem-solving skills that will result in choosing and performing appropriate and accurate tests to provide meaningful data for the establishment of a successful treatment plan. Anatomy has not changed, but time constraints in some current practice settings have result in testing "shortcuts" that can lead to an incorrect diagnosis. The Kendalls were early pioneers in performing clinical research as part of their continual quest for knowledge regarding how muscle length and weakness relate to painful conditions. A study performed in the early 1950s compared hundreds of "normal" subjects-cadets, physicians, physical therapists and student nurses (age range, 18-40 years)- with patients who had low back pain (LBP). In addition, it helped to define the differences in these imbalances between males and females. The data form this clinical study are included in table below.

Male [%(n)]				Female [%(n)]		
100 LBP Patients	**36 Physicians**	**275 Cadets**	**Case Findings**	**307 Student Nurses**	**50 Physical Therapists**	**100 LBP Patients**
58% (58)	25% (9)	5% (14)	Weakness in "upper" anterior abdominals	44% (135)	52% (26)	81% (81)
69% (69)	31% (11)	33% (91)	Weakness in "lower" anterior abdominals	79% (243)	72% (36)	96% (96)
71% (71)	45% (16)	10% (28)	Limitation of forward flexion	5% (15)	10% (5)	48% (48)
71% (71)	77% (28)	26% (72)	Right gluteus medius weakness	40% (123)	76% (38)	90% (90)
15% (15)	3% (1)	5% (14)	Left gluteus medius weakness	5.5% (17)	10% (5)	6% (6)
0% (0)	0% (0)	0.3% (1)	Bilateral gluteus medius weakness	5.5% (17)	0% (0)	12% (12)

The musculoskeletal system is composed of **striated muscles,** various types of **connective tissue** and the **skeleton.** This system provides the essential components for strength, flexibility and stability in weigh bearing.

The bones of the skeleton are joined in together by **ligaments,** which are strong, fibrous bands or sheets of connective tissue. They are flexible but not extensible. Some ligaments limit motion to such an extent that the joint is immovable; some allow freedom of movement. Ligaments are classified as **capsular**, **extracapsular** and **intracapsular**. They contain nerve endings that are important in reflex mechanism and in the perception of movement and position. Ligaments may differ from the standpoint of mechanical function. For example, a collateral ligament is an extracapsular type that remains taut throughout the range of motion, whereas a cruciate ligament (as in the knee joint) becomes slack during some movements and taut during others.

Skeletal muscle fibers are classified primarily into two type: type I (red slow twitch) and type II (white fast twitch). The two types of fibers are intermingled in most muscles. Usually, however, one type predominates, with the predominant type depending on the contractile properties of all muscle. Type I fibers seem to predominate in some postural muscles, such as the erector spinae and soleus. Type II fibers often predominate in limb muscles, where rapid, powerful forces are needed. Variability does occur, however, in these rations in the population, especially as related to development and aging.

Skeletal muscles constitute approximately 40% of body weight and are attached to the skeleton by aponeuroses, fascia, or tendons.

Aponeuroses are sheets of dense connective tissue and are glistening white in color. They furnish the broad origins for the latissimus dorsi muscles. The external and internal oblique muscles are attached to linea alba by means of aponeuroses.

Fascia is of two types: **superficial,** which lies beneath the skin and permits free movement of the skin, and **deep,** which envelopes, invests and separates muscles. Some deeps fascia furnish attachments for muscles. For example, the iliotibial tract is a strong band of deep fascia that provides attachments for the tensor fascia latae into tibia and for gluteus maximus into the femur and tibia. The thoracolumbar fascia furnishes attachment for the transversus abdominis.

Tendons are white, fibrous bands that attach muscles to bones. They have great tensile strength but are practically inelastic and resistant to stretch. Tendons have few blood muscles but are supplied with sensory nerve fibers that terminate in organs of Golgi near the musculotendinous junction. In injury that involve a severe stretch, the muscle most likely is affected, and sometimes the tendinous attachment to the bone is affected. For example, the peroneus brevis attachment at the base of the fifth metatarsal may be distruped in an inversion injury of the foot. Tendons can also rupture. When the Achilles tendon ruptures, there is retraction of gastrocnemius and soleus muscles with spasm and acute pain.

JOINT

Steadman's Concise Dictionary defines a **joint** as follows:

> Joint in anatomy, the place of union, usually more or less movable, between two or more bones… and classified into three general morphologic type: fibrous joints, cartilaginous joints, and synovial joints (11).

In this edition, the following definition adheres to the meaning as stated above with the addition of how the joints are named:

> Joint is defined as a skeletal, bone to bone connection, held together by fibrous, cartilaginous, or synovial tissue. Joints are named according to the bones that are held together.

For some joints, the bones are held so close together that no appreciable motion occurs. They provide great stability. Some joints provide stability in one direction and freedom of motion in all directions. Joints that provide little or no movement are those that hold the two sides of the body together. The sagittal suture of the skull is an immovable joint, held together by a strong fibrous membrane. The sacroiliac joint and the symphysis pubis are slightly movable and are held together by strong **fibrocartilaginous** membranes.