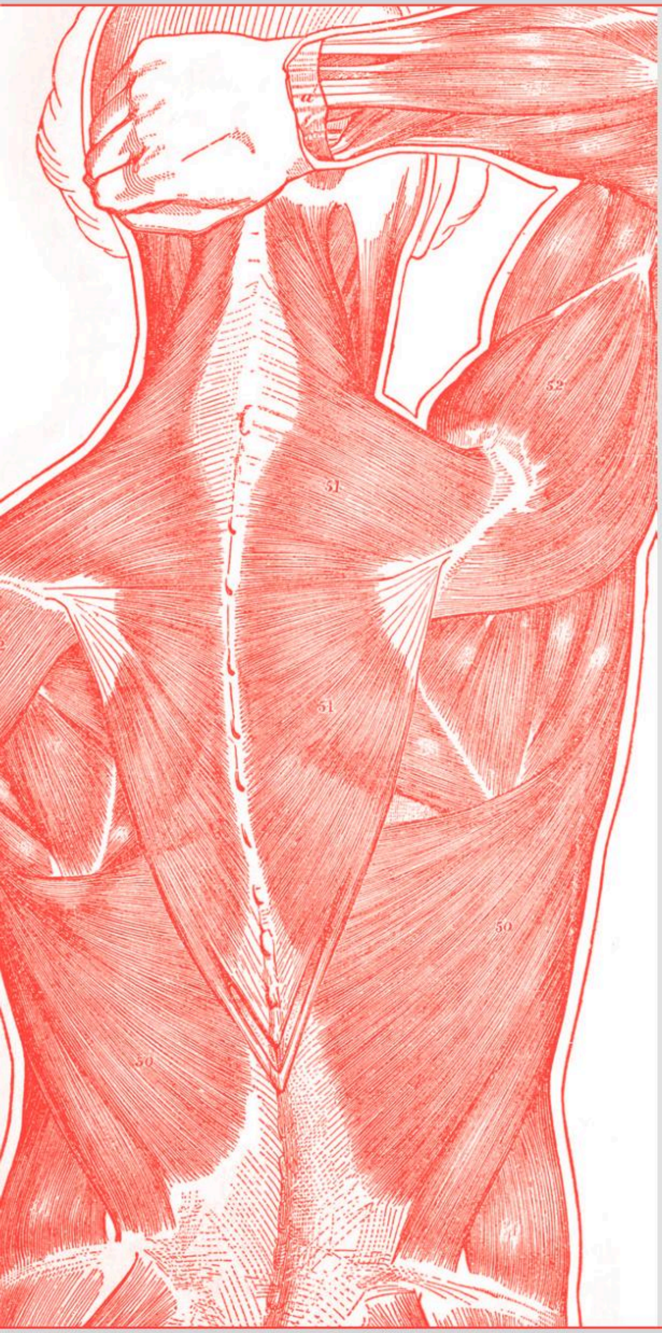

CHAPTER 1

Principles of Manual Muscle Testing

Functional movement and physical activity require muscle strength. Muscle strength is defined as the ability of the muscle to exert force. Muscle endurance is the ability of the muscle to continue to perform without fatigue. Muscle testing typically measures muscle isometric strength (no limb movement), although a few tests in this book (heel rise and sit to stand) are tests more of muscle endurance but performed isotonically (with limb movement). This chapter will provide an overview of manual muscle testing performed to assess muscle strength for a specific movement.

GRADING SYSTEM

Grades for a manual muscle test are recorded as numeric ordinal scores ranging from zero (0), which represents no discernable muscle activity, to five (5), which represents a maximal or best-possible response, or as great a response as can be evaluated by a manual muscle test. Because this text is based on specific actions (e.g., elbow flexion), a muscle test may be a test of the summed effect of the muscles involved in the action rather than a test of an individual muscle (e.g., biceps brachii). In the case of multiple muscles contributing to a single action, the muscle grade assigned represents the performance of all muscles contributing to that action, with the emphasis on the prime mover.

The numeric 0 to 5 system of grading is the most commonly used muscle strength scoring convention across health care professions. The muscle testing scale is ordinal in that the numbers have no relationship to each other. Each numeric grade (e.g., 4) can be paired with a word grade (e.g., good) that describes the test performance in qualitative, but not quantitative, terms (see following table). Use of these qualitative terms is an outdated convention and is not encouraged because these terms tend to misrepresent the strength of the tested action. For example, knee extension strength that may be 50% less than its absolute or potential strength (certainly not "normal") is still often graded as a 5 because of the amount of force still generated.[1] The knee extension action graded as 4 may generate forces as low as 10% of maximal expected force, a level clearly not appropriately described as "good."[1] Because of the problematic implications of the qualitative grading scale terms, qualitative terms have been removed from this book. The numeric grades are based on several factors that will be addressed later in this chapter.

Numeric Score	Qualitative Score	Definition
5	Normal (N)	Completes full active range of motion against gravity and can hold the test position against maximum resistance
4	Good (G)	Completes full active range of motion against gravity but cannot hold the test position against maximum resistance
3	Fair (F)	Completes full active range of motion against gravity (no resistance)
2	Poor (P)	Moves the body part with gravity minimized
1	Trace activity (T)	Movement is detected visually or with palpation, but no movement occurs
0	Zero (no activity) (0)	No discernable contraction visually or through palpation

OVERVIEW OF TEST PROCEDURES

Break Test

Manual resistance is applied to a limb or other body part only after the clinician has observed the patient's ability to perform range of motion against gravity. The term *resistance* is always used in this book to denote a concentric force provided by the tester that acts in opposition to contracting muscles. Manual resistance should always be applied opposite to the line of pull of the muscle or muscles being tested. The patient is asked to hold the body segment at midrange (for two-joint muscles) or near end range (for one-joint muscles). At this point, the patient is instructed to not allow the clinician to "break" the hold while the clinician applies manual resistance for 2 to 3 seconds, matching the isometric force of the muscle, then continuing to exert force until the maximal effort is overcome, if possible.[2] For example, in the muscle test of elbow flexion for all the elbow flexors, a seated patient is asked to flex the elbow to its end range (Grade 3) and then position the elbow in midrange (for two-joint muscle). The clinician applies resistance just proximal to the wrist, trying to "break" the muscle's hold and thus allow the forearm to move downward into extension. This is called a break test, and it is the procedure most commonly used in manual muscle testing. The break test may be a more relevant measure to represent true strength and therefore is the preferred test and is used in this text. However, there are alternatives to the break test for grading specific muscle actions, and they are described next.

Make Test

An alternative to the break test is the use of manual resistance against the line of pull of the muscle or muscle group being tested (i.e., opposite the direction of the movement) that matches the patient's resistance but does not overcome it. During the muscle contraction, the clinician gradually, over approximately 3 seconds, increases the amount of manual resistance against the muscle's action until the resistance matches the patient's ability to hold the joint in the test position. The make test is considered a submaximal test and therefore is not as reliable as the break test because the patient may be exerting only the amount of effort that matches the clinician. Chapter 2 will elaborate on this issue.

Active Resistance Test

In the active resistance test, manual resistance is applied opposite the line of pull of the muscle being tested throughout the range, starting at the muscle's fully lengthened position. The amount of resistance matches the patient's resistance but allows the joint to move through the full range. This kind of manual muscle test requires considerable skill and experience to perform and is not reliable; thus, its use is not recommended as a testing procedure. However, it may be effective as a therapeutic exercise technique.

Application of Resistance

The principles of manual muscle testing presented here and in all published sources since 1921 follow the basic tenets of muscle length-tension relationships, as well as those of joint mechanics.[2,3,4] For example, in the case of elbow flexion, when the elbow is straight, the biceps are long, but the lever arm is short. As the elbow flexes, leverage increases and becomes maximal at 90°, where the muscles are most efficient and are likely to be strongest. However, as flexion continues, the biceps shorten, and the lever arm again decreases in length and efficiency.

The point in the range where application of resistance is ideal depends on whether the muscle is a two-joint muscle or one-joint muscle. Two-joint muscles are typically tested in midrange where length-tension is more favorable.

Critical to the accuracy of manual muscle testing and scoring is the location of the applied resistance and the consistency of resistance and technique across all patients. The placement of resistance is typically near the distal end of the body segment to which the tested muscle attaches. Because force is a product of the distance from the muscle's origin, the clinician's hand placement even a few inches away from the ideal hand placement can affect the output.[5] However, there are exceptions to this rule. One exception is when resistance cannot be provided effectively without moving to a body segment distal to its attachment. For example, to muscle test shoulder and hip internal and external rotators, resistance is applied through the hand placed on the distal forearm or lower leg, respectively. Another exception involves patients with a shortened limb segment as in an amputation. The patient with a transfemoral amputation presents a challenge in applying a challenging force to assess the gluteus medius because of the shortened limb. Even if the patient could hold against maximum resistance while abducting the hip, the weight of the lower limb is so reduced and the lever arm for resistance application is so short that a Grade 5 cannot be assumed regardless of the resistance applied. A patient holding against maximum resistance may still struggle with the force demands of walking with a prosthesis. If a variation is used, the clinician should make a note of the placement of resistance to ensure consistency in testing.

The application of manual resistance should never be sudden or uneven (jerky). The clinician should apply resistance with full patient awareness and in a somewhat slow and gradual manner, slightly exceeding the muscle's force as it builds over 2 to 3 seconds to achieve the maximum tolerable intensity. Applying resistance that slightly exceeds the muscle's generated force will likely encourage a maximum effort and an accurate break test.

The clinician should also understand that the weight of the limb plus the influence of gravity is part of the test response. Heavier limbs and longer limb segments put a higher demand on the muscles that move them, such as the leg moving against gravity compared to the hand moving against gravity. When the muscle contracts in a parallel direction to the line of gravity, it is noted as "gravity minimal." It is suggested that the commonly used term "gravity eliminated" be avoided because, of course, gravity eliminated can never occur except in a zero-gravity environment.

Weakened muscles are tested in a plane horizontal to the direction of gravity with the body part supported on a smooth, flat surface in such a way that friction force is minimal (Grades 2, 1, and 0). A powder board may be used to minimize friction. For stronger muscles that can complete a full range of motion in a direction against the pull of gravity (Grade 3), resistance is applied perpendicular to the line of gravity (Grades 4 and 5). Acceptable variations to antigravity and gravity-minimal positions are discussed in individual test sections.

Stabilization

Stabilization of the body or segment is crucial to assigning accurate muscle test grades. Patients for whom stabilization is particularly important include those with weakness in the stabilizing muscles (e.g., scapular stabilizers) when testing the shoulder muscles and those who are particularly strong in the joint action being tested.

Numerous muscles, some seemingly remote from the joint of interest, can contribute as stabilizers to the performance of tested muscle actions. However, manual muscle testing is meant to test the prime mover of the joint action and minimize the input of other muscles.

To give an extreme example, shoulder abduction on the left side should not be dependent on the trunk muscles on the right side. Therefore, a patient with weak trunk muscles and limited sitting balance should be supported and stabilized either through patient positioning or by a stabilizing hand on the right shoulder.

A muscle or muscle group that is particularly strong may also require patient stabilization if the full capacity of a muscle group is to be accurately tested.[6] For example, a tester may not be able to break the knee extension action of a patient who is allowed to rise off of a support surface during the performance of a break test. However, the same patient, properly stabilized by the clinician, an assistant, or a belt during testing, may not be able to hold against maximum clinician resistance, thus causing a "break" in the muscle contraction that indicates the patient has a muscle Grade 4 rather than 5.

Patient Effort

To obtain an accurate grade in manual muscle testing, the patient must be instructed to exert their maximum effort. The clinician should also be prepared to provide strong, if not maximum, resistance to help elicit the patient's maximum effort. Maximum effort should not be confused with maximum output. To achieve maximum effort, the clinician should consider using vocal encouragement, similar to a coach's methods. Without maximum, voluntary effort, an accurate grade cannot be determined. This is true regardless of age or ability.

CRITERIA FOR ASSIGNING A MUSCLE TEST GRADE

The grade given on a manual muscle test comprises both subjective and objective factors. Subjective factors include the clinician's impression of the amount of resistance given during the actual test and the amount of resistance the patient actually holds against during the test. Objective factors include the ability of the patient to complete a full range of motion or to hold the test position once placed there, the ability to move the part against gravity, or an inability to move the part at all. All these factors require clinical judgment, which makes manual muscle testing a skill that requires considerable practice and experience to master. An accurate test grade is important not only to establish the presence of an impairment but also to assess the patient's longitudinal status over time. Clinical reasoning is necessary for the clinician to determine the causes for the lack of ability to complete the full range or hold the position, ascertain which is most applicable, and decide whether manual muscle testing is appropriate.

Consistent with a typical orthopedic or neurological exam, the patient is first asked to perform the active movement of the muscle to be tested independently without clinician or mechanical assistance. This active movement informs the clinician of the patient's willingness and ability to move the body part, of the available range in the related joint(s), and whether there are limitations to full range, such as pain, excess tone, or weakness. Active movement without resistance and through the full range of the action being tested is the equivalent of a Grade 3. Active movement is also called active range of motion and begins every muscle test to help determine the appropriate test position and amount of resistance to apply.

Grade 5 Muscle

A grade of 5 is assigned when a patient can complete full active range of motion (active movement) against gravity (Grade 3) followed by holding the test position against maximum resistance without a break in the muscle's contraction. Grade 5 is a measure of absolute or potential strength, not expected strength. If the clinician can break a patient's hold, a Grade 5 should *not* be assigned. The clinician should recognize that some muscles, such as the quadriceps, will be overestimated because of the absolute strength of the muscle. In fact, it is doubtful that a manual muscle test can discern absolute strength of the quadriceps. Chapters 7 and 8 describe alternate tests to accurately assess absolute strength.

The inherent wide range of "normal" muscle performance (Grade 5) typically leads to a considerable underestimation of a muscle's capability.[7] If the clinician has no experience in examining people who are free of disease or injury, it is unlikely that there will be any realistic or accurate assessment of what is Grade 5 and how much normality can vary. In general, a student learns manual muscle testing by practicing on classmates, but this provides only minimal experience compared with what is needed to master the skill necessary to test a wide variety of patients. It should be recognized, for example, that the average clinician cannot "break" knee extension in a reasonably fit young person, even by doing a handstand on their leg! A clinician may not be aware of the underestimation of the muscle contraction unless quantitative measures of strength are also used, such as in a sit-to-stand test for the quadriceps. Contributing to an underestimation of weakness is the inability of some clinicians (oftentimes female) to apply adequate resistance to elicit the patient's maximum effort.[8]

Grade 4 Muscle

Grade 4 is assigned when the patient can complete full active range of motion (active movement) against gravity but is not able to withstand a break test against the clinician's maximum resistance. Appropriate stabilization is critical to determine the true difference between a Grade 5 and Grade 4 muscle. A Grade 4 muscle "gives" or "yields" to some extent at the end of its test position with maximal or submaximal resistance. When maximal resistance results in a break or give, irrespective of age or disability, the muscle is assigned a Grade 4. However, if pain limits the ability to generate a maximal effort against the force applied by the clinician, evaluation of actual strength may not be realistic or accurate and should be documented as such. For example, in the presence of pain that limited the ability to generate a maximal contraction, documentation might say "Elbow flexion appeared strong but painful" or "Elbow flexion appeared weak and painful." Documentation such as this helps differentiate between a neurological cause of the inability to generate a maximum contraction and other causes such as pain.

Grade 3 Muscle

The Grade 3 muscle test is based on an objective measure of movement throughout the joint's range against gravity. For a Grade 3 to be assigned, the individual muscle or muscle group can complete a full range of motion against the resistance of gravity. This is also called "active range of motion." Even if a tested muscle can move through the full range against gravity and tolerate a small or "mild" amount of resistance, the muscle is assigned a Grade 3.

Direct force measurements have demonstrated that the force level of the Grade 3 muscle is quite low (less than 5% of normal for knee extension) so that a much greater span of functional loss exists between Grades 3 and 5 than between Grades 3 and 1.[9] A Grade 3 may represent a *functional threshold* for some muscle actions tested (e.g., elbow flexion during feeding); however, a Grade 3 may fall far short of the functional requirements of many lower extremity muscles during weight-bearing activities, particularly for such muscle groups as the hip abductors and the ankle plantar flexors. The clinician must be sure that muscles given a Grade 3 are not in the joint "locked" position during the test (e.g., locked elbow when testing elbow extension).

Grade 2 Muscle

Grade 2 is assigned to a muscle or muscle group that can move the body segment when gravity is minimized. This position is typically described as the horizontal plane of motion. Movement in this plane may be eased by use of a powder board or other such friction-minimizing surface.

Grade 1 Muscle

Grade 1 is assigned when the clinician can detect visually or by palpation some contractile activity in one or more of the muscles that participate in the action being tested (provided that the muscle is superficial enough to be palpated). The clinician also may be able to see or feel a tendon pop up or tense as the patient tries to perform the movement. However, there is no movement of the body part as a result of this contractile muscle activity.

Patient positioning is less important in Grade 1 testing because a Grade 1 muscle can be detected in almost any position. When a Grade 1 muscle is suspected, the clinician should passively move the part into the test position and ask the patient to hold the position and then relax; this will enable the clinician to palpate the muscle or tendon, or both, during the patient's attempts to contract the muscle and also during relaxation. Care should be taken to avoid substitution of other muscles.

Grade 0 Muscle

Grade 0 muscle is assigned when the clinician's palpation or visual inspection fail to provide evidence of contraction. This does not mean there is no muscle activation. In fact, electromyography may demonstrate that some activation is present. Thus, the phrase "no discernable contraction" defines a Grade 0 in this text.

Plus (+) and Minus (–) Grades

Use of plus (+) or minus (–) delineations to manual muscle test grades is discouraged. Avoiding the use of plus or minus signs restricts manual muscle test grades to those that are meaningful, defendable, and reliable. The use of pluses and minuses adds a level of subjectivity that lacks reliability, especially for grades of 3 or greater. However, in the case of Grade 2, described earlier, there is a considerable difference between the muscle that can complete full range in a gravity-minimized position (horizontal position) and the one that cannot complete full range but can achieve some joint movement. Therefore, Grade 2– is acceptable when the muscle can complete partial range of motion in the horizontal plane, gravity minimized. The difference between Grade 2 and Grade 1 muscles represents such a broad functional difference that a minus sign may be important in assessing even minor improvements in function. The clinician is encouraged to supplement the grade with descriptive documentation of the quality of movement.

Grade 4 Muscle Revisited

Grade 4 has a huge range of strength ability, spanning from the limb tolerating a small amount of resistance notwithstanding a maximal break test effort. In fact, considerable discussion has occurred about the validity of Grade 4. In one study, comparing manual muscle testing with isokinetic dynamometry, Dvir found that up to 86% of the muscle strength potential is spanned by Grade 4.[10] More recently, Bohannon found that force values for muscles that were graded as "normal" ranged from 80 to 625 Newtons,[7] an astronomical difference, further demonstrating how difficult it is to distinguish a "good" muscle from a "normal" muscle.

Accurate muscle grades are especially challenging to assign to older adults. By the time a person reaches the age of 80 years, approximately 50% of their muscle mass and strength may be lost due to natural decline.[11] Older adults may not be familiar or comfortable in exerting maximum effort, and clinicians may have an ageist bias that assumes older adults do not need the same strength requirements as a younger person, and so, they may grade more generously. Unfortunately, these lower expectations may result in the assignment of a grade of "normal" (5) or worse, "within normal limits" (WNL), even though the individual's strength is half of what it used to be. Functionally, this same 80-year-old assigned "normal" strength may be unable to get out of a chair without pushing on the arms or to ascend stairs without pulling on the railing. Certainly, this person's functional performance is not WNL or within functional limits (WFL). Inaccurate muscle grading based on the patient's age, sex, presumed strength, or because the clinician cannot apply adequate resistance must be avoided.

There are numerous instances in which a Grade 4 muscle cannot meet its functional demands. When the gluteus medius is graded as a 4, a patient will display a positive Trendelenburg sign. This is one of the reasons the test position requires so much effort. When the soleus is graded a 4, the heel rise fails to occur during the latter portion of the stance phase of gait, which reduces gait speed.[12] When the abdominals are Grade 4, there is difficulty stabilizing the pelvis while arising from bed or when sitting up, and this often results in back pain. Calling a muscle "good," rather than Grade 4, simply is not "good" enough. Based on Dvir's and Bohannon's findings, it is these author's opinions that many more Grade 4s should be assigned, rather than Grade 5, especially considering the aging patient population.

As noted previously, there is no other term in muscle testing that is more problematic than the term "good" used to denote numerical Grade 4. Too often, clinical practitioners, including therapists and physicians, construe the term "good" in the literal sense, interpreting "good" to mean the muscle's strength is totally adequate. This assumption, that a Grade 4 is adequate, is quite erroneous considering the enormous span of muscle strength within Grade 4. If used in the qualitative sense, the assumption that a Grade 4/good is adequate may deprive the patient of beneficial rehabilitation.

It is unclear how a grade of "good" became synonymous with achievement of a satisfactory end point of treatment. Certainly, the pressure from third-party payers to discharge patients as soon as possible does not help the clinician to fulfill the minimum goal of reaching "prior level of function." Nonetheless, the opportunity for patients to recover muscle strength to the fullest extent possible is a primary goal of an intervention. If this goal is not met, patients (especially aging individuals) may lose their independence or find themselves incapable of returning to a desired sport or activity because their weak muscles fatigue too quickly. Athletes who have not fully recovered their potential strength before returning to a sport are far more likely to suffer a reinjury, potentially harming themselves further.

In summary, a "good" muscle is not always good. Everything must be done to ensure accuracy in manual muscle test grading and to provide the intervention necessary to fully restore strength and function to "normal." Substituting the numerical system of 5 to 0 for the subjective terms "good" or "normal" in manual muscle testing assessment is a start in the right direction as is being aware of the span of absolute or potential strength of individual muscles. Chapters 7 to 9 will assist with this familiarization.

Available Range of Motion

When muscle shortness ("tightness"), a contracture, or fixed joint limitation (e.g., total knee replacement) limits joint range of motion, the patient performs only within the range available. In this circumstance, the *available range* is the full passive range of motion for that patient at that time, even though it is not "normal." This is the range used to assign a muscle testing grade. For example, the normal knee extension range is 135 degrees to 0 degrees. A patient with a 20-degree knee flexion contracture is tested for knee extension strength in the middle of the ideal range, where the muscle is considered the strongest. If this range (in sitting) can be completed with maximal resistance, the grade assigned would be a 5. If the patient cannot actively complete that range because of a structural issue but can hold against maximum resistance, the grade assigned may still be a 5. However, the clinician should document the patient's muscle grade within the limited range. For example, "knee extension is graded a 5 in the presence of a 20-degree knee flexion contracture" or "the presence of the patient's 20-degree knee flexion contracture did not appreciable affect the patient's ability to exert maximum force, achieving a Grade 5."

Screening Tests

In the interests of time and cost-efficient care, it is often unnecessary to perform a muscle test on each muscle of the body. As the strength of various muscle actions tend to be correlated and internally consistent,[7] a systematic testing of a limited number of muscle actions often will suffice. Three screening indexes warrant mentioning. Each was developed with a specific diagnostic group in mind and allows for the calculation of a total score. The first, the Motricity Index, was developed for patients with stroke and includes three muscle actions of the upper limb (shoulder elevation, elbow flexion, and hand grasp) and three muscle actions of the lower limb (hip flexion, knee extension, and ankle dorsiflexion).[9] The second, the Motor Index Score, was developed for patients with spinal cord injury and includes muscle actions representative of key nerve root levels in the upper and lower limbs (elbow flexion [C5], wrist extension [C6], elbow extension [C7], finger flexion [C8], small finger abduction [T1], hip flexion [L2], knee extension [L3], ankle dorsiflexion [L4], great toe extension [L5], and ankle plantarflexion [S1]).[13] The final test, the Medical Research Council Sum Score, was produced to capture weakness in patients with Guillain-Barré but has since been used with other patients with dispersed weakness. It includes most of the actions included in the Motricity Index (shoulder abduction, elbow flexion, wrist extension, hip flexion, knee extension, and ankle dorsiflexion).[14]

Never should the clinician use phrases such as WNL or WFL for a screening exam. If a nonspecific strength exam is performed (e.g., through observation of tasks), documentation is better served with terms like "patient demonstrated no difficulty performing task," rather than making a judgment about the degree of strength present.

To screen for muscles that need definitive testing, the clinician can use a number of techniques to identify movements that do and do not need testing. Observation of the patient before the examination will provide valuable clues to muscular weakness and performance deficits. For example, the clinician can do the following:

- Observe the patient as they enter the treatment area to detect gross abnormalities of gait or other aspects of mobility.
- Observe the patient doing other everyday activities such as rising from a chair, completing admission or history forms, or removing street clothing.
- Ask the patient to walk on the toes and then on the heels.
- Ask the patient to grip the clinician's hand.
- Perform gross checks of bilateral muscle groups, such as reaching toward the floor, overhead, and behind the back.

If evidence from the previous "quick checks" suggests a deficit in movement, in the interest of time and to optimize the patient's clinic visit, manual muscle testing can quickly be focused to the region observed to be weak.

PREPARING FOR THE MUSCLE TEST

For the test session to be successful, the clinician and the patient must work in harmony. This means that some basic principles and inviolable procedures must be second nature to the clinician.

1. The patient should be as free as possible from discomfort or pain for the duration of each test. It may be necessary to allow some patients to move or be positioned differently between tests.
2. The environment for testing should be quiet and nondistracting. The ambient temperature should be comfortable for the partially disrobed patient.
3. The testing surface must be firm to help stabilize the body part being tested. The ideal is a firm surface, minimally padded or not padded at all. The firm surface will not allow the trunk or limbs to "sink in." Friction of the surface material should be kept to a minimum. When the patient is reasonably mobile, a plinth or table is fine, but its width should not be so narrow that the patient is afraid of falling or sliding off. Sometimes a low mat table is the more practical choice. The height of the table should be adjustable to allow the clinician to use proper leverage and body mechanics.
4. Patient position should be carefully organized so that position changes in a test sequence are minimized. The patient's position must permit adequate stabilization of the part or parts being tested by virtue of body weight or with help provided by the clinician.
5. All materials needed for the test must be at hand. This is particularly important when the patient is anxious for any reason or is too weak to be safely left unattended. Materials needed include the following:

- Manual muscle test documentation forms (Fig. 1.1)
- Pen, pencil, or computer
- Pillows, towels, pads, and wedges for positioning
- Sheets or other draping linen
- Goniometer
- Stopwatch
- Specific equipment for specific functional tests
- Test forms for functional tests
- Interpreter (if needed)
- Assistance for turning, moving, or stabilizing the patient
- Emergency call system (if no assistant is available)
- Reference material

PRIME MOVERS

Within each chapter are tables indicating the muscles involved in the action that is tested (e.g., shoulder flexion). When prime movers have been identified for a particular action, they are in boldface type. For example,

Grade 2, Grade 1, and Grade 0

Position of Patient: Supine with head on table. Arms at sides. Note: The gravity-minimized position (side lying) is not recommended for any tests of the neck for Grades 2 and below because test artifacts are created by the clinician in attempting to support the head without aiding the motion.

Instructions to Clinician: Stand at end of table, facing patient. Support head with two hands under the occiput. Place fingers just at the base of the occiput, lateral to the vertebral column to attempt to palpate the capital extensors (Fig. 3.5). Head may be slightly lifted off table to reduce friction.

Test: Patient attempts to look back toward clinician without lifting head from the table.

Instructions to Patient: "Tilt your chin up" OR "Look back at me. Don't lift your head."

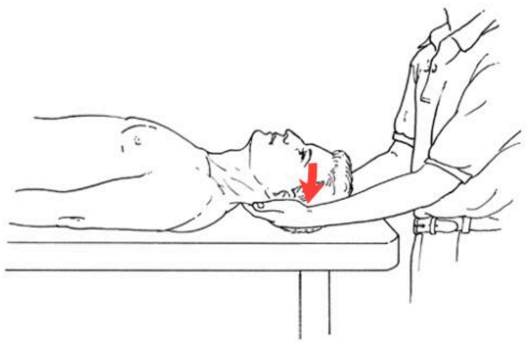

FIGURE 3.5

Grading

Grade 2: Patient completes limited range of motion.

Grade 1 and Grade 0: Palpation of the capital extensors at the base of the occiput just lateral to the spine may be difficult; the splenius capitis lies most lateral, and the recti lie just next to the spinous process.

Clinical Relevance

Clinicians are reminded that the head is a heavy object suspended on thin support (neck). Whenever testing with patient's head off the table, care should be used for the patient's safety and comfort, especially in the presence of suspected or known neck or trunk weakness or pain. Always place a hand under the head to be ready to support it should the muscles give way.

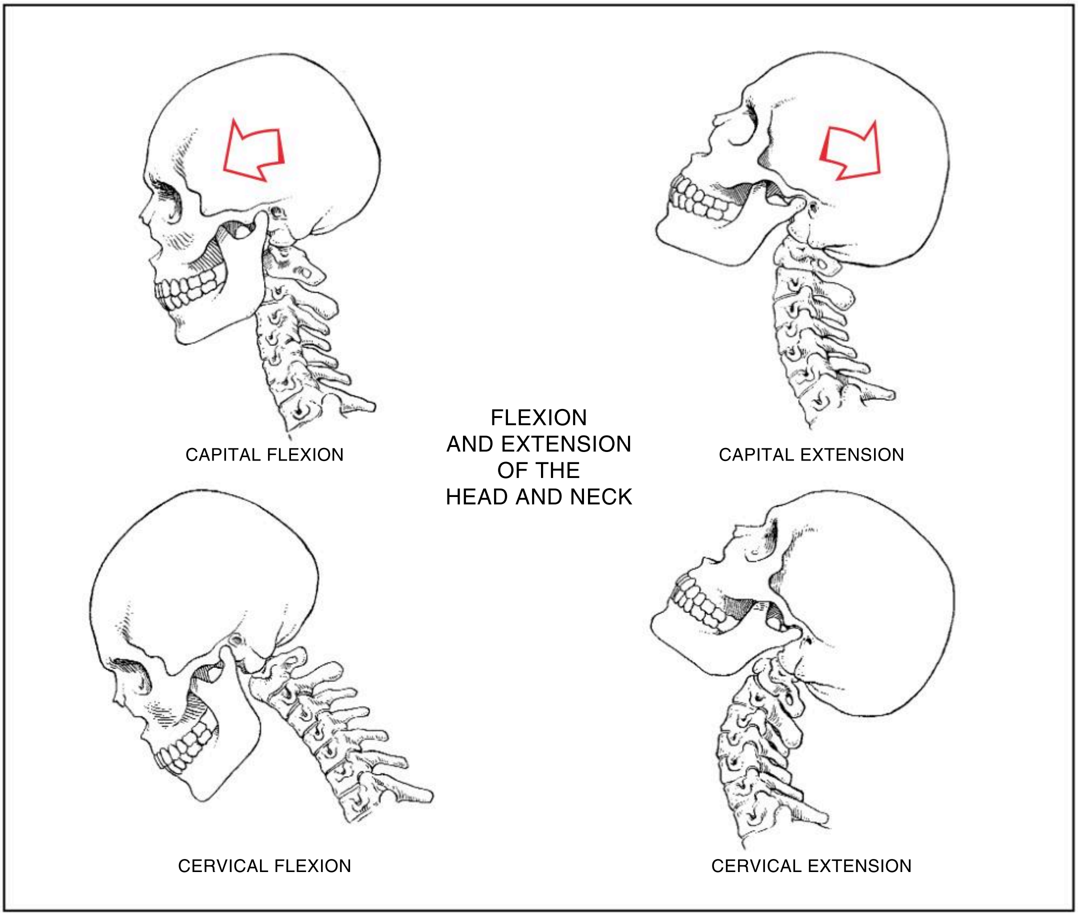
CAPITAL FLEXION
FLEXION
AND EXTENSION
OF THE
HEAD AND NECK
CAPITAL EXTENSION
CERVICAL FLEXION
CERVICAL EXTENSION

PLATE 1

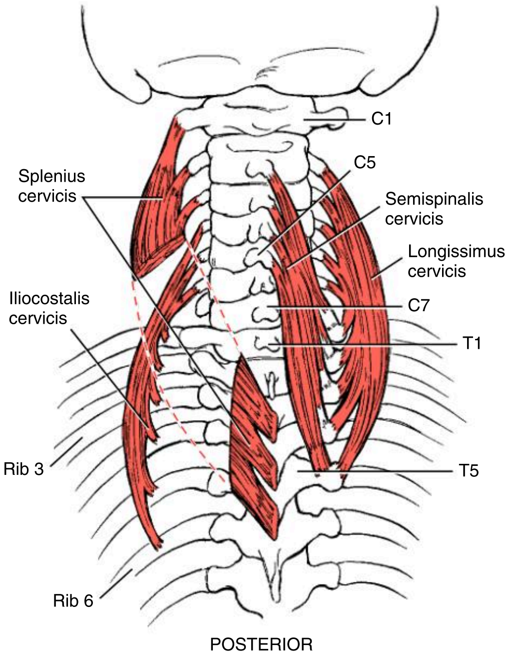

FIGURE 3.6

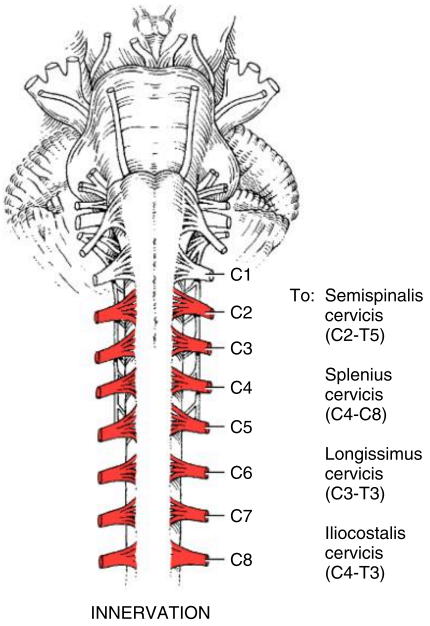

FIGURE 3.7

Range of Motion
0° to <30°

Table 3.2 **CERVICAL EXTENSION**

I.D.	Muscle	Origin	Insertion	Function
64	Longissimus cervicis	T1-T5 vertebrae (transverse processes) variable	C2-C6 vertebrae (transverse processes)	Extension of the cervical spine (both muscles) Lateral bending of cervical spine to same side (one muscle)
65	Semispinalis cervicis	T1-T5 vertebrae (transverse processes)	Axis (C2)-C5 vertebrae (spinous processes)	Extension of the cervical spine (both muscles) Rotation of cervical spine to opposite side (one muscle) Lateral bending to same side
66	Iliocostalis cervicis	Ribs 3–6 (angles)	C4-C6 vertebrae (transverse processes, posterior tubercles)	Extension of the cervical spine (both muscles) Lateral bending to same side (one muscle) Depression of ribs (accessory)
67	Splenius cervicis (may be absent or variable)	T3-T6 vertebrae (spinous processes)	C1-C3 vertebrae (transverse processes)	Extension of the cervical spine (both muscles) Rotation of cervical spine to same side (one muscle) Lateral bending to same side (one muscle) Synergistic with opposite sternocleidomastoid
124	Trapezius (upper)	Occiput (protuberance and superior nuchal line, middle one-third) C7 (spinous process) Ligamentum nuchae T1-T12 vertebrae occasionally	Clavicle (posterior border of lateral one-third)	Elevation of scapula and shoulder (“shrugging”) (with levator scapulae) Rotation of head to opposite side (one) Capital extension (both) Cervical extension (both)
68	Spinalis cervicis (often absent)	C7 and often C6 vertebrae (spinous processes) Ligamentum nuchae T1-T2 vertebrae occasionally	Axis (spinous process) C2-C3 vertebrae (spinous processes)	Extension of the cervical spine
Others				
69	Interspinales cervicis			
70	Intertransversarii cervicis			
71	Rotatores cervicis			
94	Multifidi			
127	Levator scapulae			

Cervical extensor muscles are limited to those that act only on the cervical spine with motion centered in the lower cervical spine.

Grade 5 and Grade 4

Position of Patient: Prone with head off end of table. Arms at sides.

Instructions to Clinician: Stand next to patient's head. Ask patient to lift head while looking at the floor. If sufficient range is present, place hand applying resistance over parieto-occipital area (Fig. 3.8). Place other hand below the chin, ready to support the head should it suddenly give way during resistance.

Test: Patient extends neck without tilting chin.

Instructions to Patient: "Push up on my hand but keep looking at the floor. Hold it. Don't let me push your head down."

Grading

Grade 5: Patient holds test position against strong resistance. Clinician must use clinical caution because these muscles are not strong, and their maximum effort will not tolerate much resistance.

Grade 4: Patient holds test position against moderate resistance.

FIGURE 3.8

Grade 3:

Position of Patient: Prone with head off end of table. Arms at sides.

Instructions to Clinician: Stand next to patient's head with one hand supporting (or ready to support) the forehead (Fig. 3.9).

Test: Patient extends neck without looking up or tilting chin.

Instructions to Patient: "Lift your forehead from my hand, and keep looking at the floor."

Grading

Grade 3: Patient holds test position but without resistance.

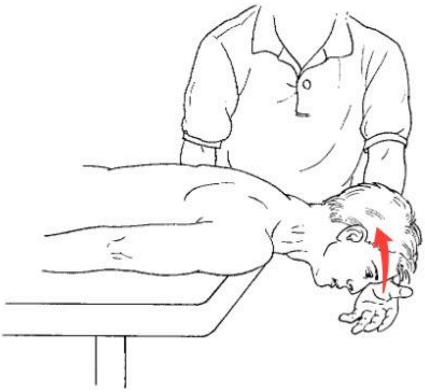

FIGURE 3.9

Alternate Test for Grade 3: This test should be used if there is known or suspected trunk extensor weakness. The clinician should always have an assistant participate to provide protective guarding under the patient's forehead. This test is identical to the preceding Grade 3 test except that stabilization is provided by the clinician to the upper back by the forearm placed over the upper back with the hand cupped over the shoulder (Fig. 3.10).

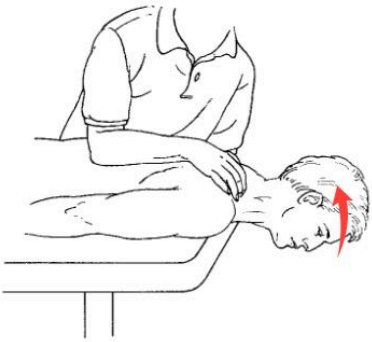

FIGURE 3.10

Grade 2, Grade 1, and Grade 0

Position of Patient: Supine with head fully supported by table. Arms at sides.

Instructions to Clinician: Stand at the patient's head, facing the patient. Place both hands under the patient's head. Fingers should be distal to the occiput at the level of the cervical vertebrae for palpation (Fig. 3.11). Ask patient to push head into clinician's hands without any tilt.

Test: Patient attempts to extend neck into table without tilt.

Instructions to Patient: "Try to push your head down into my hands."

Grading

Grade 2: Patient moves through small range of neck extension by pushing into clinician's hands.

Grade 1: Contractile activity palpated in cervical extensors.

Grade 0: No discernable palpable muscle activity.

Clinical Relevance

Patients with a loss of cervical lordosis may have weak cervical extensors. Weak cervical extensors may be a risk factor for cervical kyphosis and dropped head syndrome.[8]

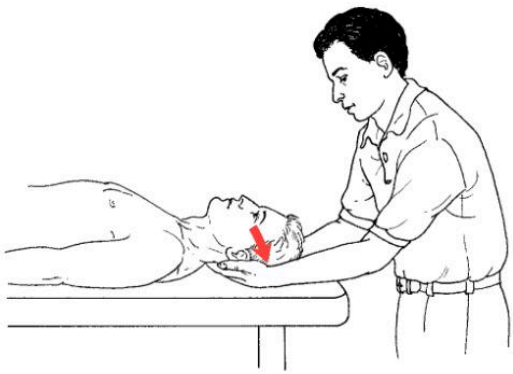

FIGURE 3.11

CAPITAL FLEXION (CHIN TUCK)

(Deep cervical flexors)

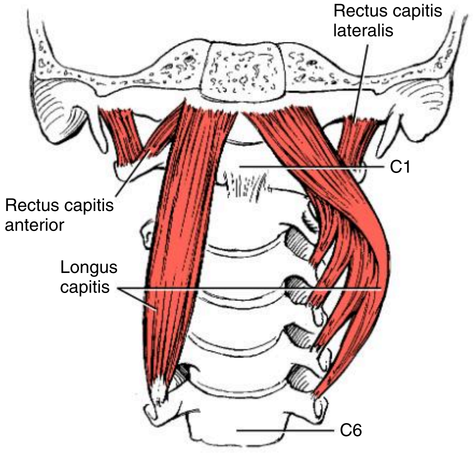

FIGURE 3.12

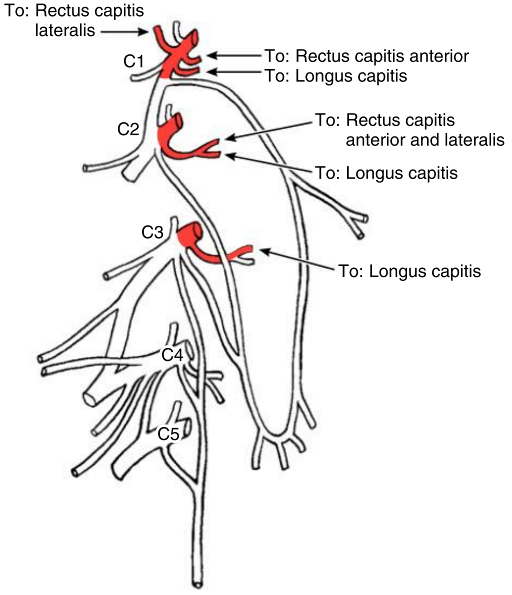

FIGURE 3.13

Range of Motion
0°–10°–15°

Table 3.3 CAPITAL FLEXION (CHIN TUCK)

I.D.	Muscle	Origin	Insertion	Function
72	Rectus capitis anterior	Atlas (C1) transverse process and lateral mass	Occiput (basilar part, inferior surface)	Capital flexion Stabilization of atlanto-occipital joint
73	Rectus capitis lateralis	Atlas (transverse process)	Occiput (jugular process)	Lateral bending of head to same side (obliquity of muscle) Assists head rotation Stabilizes atlanto-occipital joint (assists) Capital flexion
74	Longus capitis	C3-C6 vertebrae (transverse processes, anterior tubercles)	Occiput (basilar part, inferior surface)	Capital flexion Rotation of head to same side (muscle of one side)
Others				
Suprahyoids				
75	Mylohyoid			
76	Stylohyoid			
77	Geniohyoid			
78	Digastric			

(Deep cervical flexors)

The deep cervical flexors (longus capitis, rectus capitis, and colli) achieve capital flexion (nodding), called the chin tuck movement. The longus capitis and longus colli provide an active element of vertical stability to the cervical spine.[9] The weight of the head makes up one-seventh of body weight. Forward head posture (FHP) is the structural forward positioning of the head away from the center line of the body. In FHP, upper cervical vertebrae are extended and lower cervical vertebrae are flexed, increasing the force required to support the head by up to 3.6 times more than normal aligned posture.[10] In FHP, there is increased extension in the upper cervical joints and at the atlanto-occipital joint, causing the face to be directed upward (Fig. 3.14). FHP results in lengthening of the lower cervical flexors (sternocleidomastoid, scalenes, and upper cervical [capital] extensors) and results in weakness of the lower cervical extensors and upper capital flexors. FHP is commonly accompanied by thoracic kyphosis.

Starting Position of Patient: In all capital and cervical tests, the patient is supine with head supported on table and arms at sides (Fig. 3.15). The clinician should be aware of and avoid the tendency of the patient to use thoracic extensors to retract the head and cervical spine when exerting a maximal effort during testing of capital flexion.

FIGURE 3.14

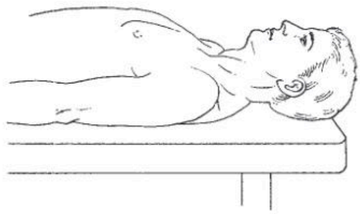

FIGURE 3.15