CHAPTER 10

Case Studies

Introduction

This chapter serves as a brief summary of the muscle-testing performance concepts presented throughout this book. Concepts are amplified using a series of case studies that illustrate the need for various forms of muscle testing. Each case features a real patient with a need for specific data to verify clinical findings and understand functional deficits. An overview of the problem-solving approach used by the therapist is presented for each.

The variety of tests available to therapists is illustrated in these case studies. The diagnoses presented are common, and each case is intended to highlight the rationale for specific muscle test selection.

Case 1. Shoulder Pain

The patient was a 56-year-old male investment banker who developed right shoulder pain after a weekend of working with his arms extended over his head while painting the ceilings in his home. Initial observation reveals forward shoulders and abducted scapulae. Because of his forward shoulder posture, weakness of scapular stabilizers was suspected. Testing of the scapular upward rotators revealed Grade 3 strength. Muscle testing of the glenohumeral muscles revealed Grade 3 of the right external rotators (teres minor and infraspinatus) and Grade 4 strength of the shoulder abductor (middle deltoid), with pain that limited full effort. Shoulder internal rotation, flexion, and extension strength were all Grade 5 and non-painful and considered non-contributing. Given his response of pain to shoulder abduction and weakness of the scapular upward rotators, faulty scapular-thoracic and glenohumeral mechanics were suspected as contributing to pain at the shoulder.

Attention to scapular function was part of the evaluation because glenohumeral joint movement is only possible if the scapula also moves simultaneously. It was thought that focusing on the glenohumeral joint would not resolve this patient's problem because of weakness of the scapulohumeral muscles, specifically the serratus anterior and lower trapezius. Strengthening of the scapular stabilizers repositions the scapula. When the scapula is repositioned through strength and muscle re-education, the humerus will be reseated properly in the glenoid fossa, thus opening the sub-acromial space and allowing more freedom for the supraspinatus to slide beneath the acromion process. This is likely to improve the joint mechanics, relieve pain, and possibly prevent a recurrence.

This case example reflects a typical patient who is referred to physical therapy. The original symptom was pain, but the patient's discomfort was the consequence of mechanical dysfunction related to muscle weakness. Knowledge of anatomy, kinesiology, and manual muscle testing enabled the therapist to isolate the root causes of the patient's painful condition.

Case 2. Compromised Gait and Function Secondary to Muscle Weakness

The patient is a 68-year-old retired man. One weekend he went to the movies with his wife and, after 2 hours of sitting, found he could not get up from the chair without a great amount of effort. This embarrassing incident prompted him to seek help, and he referred himself to an older-adult wellness clinic.

Evaluation revealed a pleasant-appearing gentleman with flexed hips (~20°) and knees (~15°) when standing upright. With therapist cueing, his lower extremity positioning could be corrected to a more erect posture, but only momentarily. He was of average height (68 in.) but was overweight, stating that he weighed approximately 240 lb at the time of initial evaluation (body mass index = 36, which is obese).

Observation revealed clear difficulty rising from the standard 17-in chair in the waiting room, as evidenced by using his arms and rocking back and forth several times before he could stand up. A physical activity history showed low activity, sitting being the predominant activity, and difficulty walking three blocks. Clinical impression was sarcopenia secondary to physical inactivity and age.

Functional testing was conducted first, to focus the muscle strength exam. The gait evaluation revealed the following: slow usual gait speed (2 mph or 0.9 m/s), forward trunk lean during the entire gait cycle, pelvic drop bilaterally during the stance phase (exhibited by a "waddling" gait), failure to flex the knee at loading, and an absence of heel rise at the end of the stance phase as exhibited by a flat foot and shortened stride. These observations suggested possible weakness of the following muscle groups: core, hip extensors, hip abductors, knee extensors, and plantar flexors. Thus additional muscle testing was done.

Because this man was large, it became immediately apparent to the therapist that manual muscle testing was not feasible given the therapist's size in relation to the patient's. Therefore alternative testing using the leg press and the one-repetition maximum (1-RM) method was chosen. The patient was also tested using the standard 25× heel rise test for plantar flexors (described on page 278).

Total Lower Extremity Strength Testing

The leg press provides a composite value for total lower extremity extension (ankle plantar flexion, knee extension, and hip extension). The leg press is ideal because norms are available for men and women of all ages (see Table 7.4, page 313). Initial resistance was based on the norms for a 68-year-old man that were 1.4 times his body weight. However, because of this patient's difficulty in rising from a chair, a functional task that requires a minimum of 50% of the body's weight (120 pounds), RM testing was started at 120 pounds (50% of body weight). However, he could not move the weight stack, informing the therapist why he had difficulty rising from a chair unassisted. Further adjustments downward over two trials achieved a 3-RM at 90 pounds (~40% body weight).

Hip Extension

A prone hip extension test was performed bilaterally and the patient was able to lift one thigh from the table, but not complete full range. He was unable to lift the other leg from the table (Grade 2 bilaterally). To establish the appropriate amount of resistance for effective strengthening, RM testing was chosen next. Cuff weights were attached to his ankle (one side at a time) to provide resistance. In a standing position, the patient was able to extend his hip with 7 pounds for six repetitions on the right side, and 5 pounds for six repetitions on the left while using arm support for balance and stability.

Knee Extension

A RM using the leg extension machine (open chain approach) was used to isolate the knee extensors. The patient was seated on the leg extension machine, and initially 50 pounds was selected from the weight stack to test one leg at a time. Fifty pounds was chosen because it is slightly less than half of the bilateral leg press 1-RM. The patient was not able to complete the full range, so the weight was decreased by 10 pounds. He was then able to complete full range with utmost effort. To confirm the RM, the patient was asked to perform as many repetitions as possible. He was unable to do another repetition with full range; therefore his 1-RM for the first leg was 40 pounds. The test was then repeated on the other side and achieved a 4-RM at 30 pounds. (Note: Open chain movements generally produce less force than what is achieved on the leg press because of the isolation of the knee extensors.)

Hip Abduction

Manual muscle testing in a side-lying position revealed an inability to lift either leg against gravity, Grade 2, that was confirmed with the ability to abduct each leg in supine through full range. To provide a RM to inform the exercise prescription, the only feasible option for accurate testing given the patient's size was a cable tensiometer affixed to an immovable object such as the wall. The patient stood with his back against the wall using the back of a chair for balance and stability, with a cuff attached to the cable tensiometer around his ankle. He was asked to abduct his leg with as much force as possible while keeping his opposite heel against the wall. The tensiometer cable was set so that the contraction elicited was isometric in the nearly hip neutral position, which is consistent with the strength demand in gait. Three repetitions were requested and the top value of 67 pounds was recorded. The weight of this patient's head, arms, and trunk (i.e., the demand on his hip abductors) would be approximately 160 pounds. Thus a 67-pound force output is not sufficient to keep his pelvis in the midline during gait. Additionally, this lack of strength would increase the work of walking and increase his fatigue. Although not reported, the other hip was also tested and

values were comparable.

Plantar Flexion

The patient's plantar flexors were tested using a standing plantar flexion test because of its ease and functionality. Given a lack of heel rise during gait, it was expected the patient would be in the lower part of the range of normal. Testing of each leg revealed an ability to accomplish five repetitions on the right and four on the left, which corresponds to a Grade 4. The traditional plantar flexion test (see page 278) requires 25 repetitions of at least 2-inch clearance.[1] Norms for a male of 60+ years require completing from 4 to 27 heel raises of at least 2-inch clearance.[2]

Core testing

Core testing was conducted using a modified plank test as the patient was unable to assume a full plank secondary to inflexible feet. Core testing was conducted because of the patient's flexed posture and fatigue when walking three blocks. The RM was 4 seconds. A "normal" plank is 60 seconds in a full plank (legs extended and weight on toes). His result is consistent with individuals who exhibit a forward-leaning posture such as when using a walker. These individuals who cannot walk upright independently can exhibit trunk weakness of 85% or more.

In summary, this patient's knee extension strength was Grade 4 with a 4-RM of 30 pounds and 40 pounds, hip extensors were Grade 2 with 6 and 5 pounds at 6-RM, hip abductors were Grade 2 with RM of 67 pounds, and plantar flexors were Grade 4 with a 4- and 5-RM. Modified plank for core strength equaled 4 seconds. These grades indicate muscle weakness of a magnitude that compromises physical activity, alters the normal gait pattern, and explains his inability to rise from a chair without using the arms. The instrumented tests provided specific numbers that could be used in context with the body weight demands of daily activities and help establish the appropriate amount of resistance for an effective exercise program. It should be noted that this individual walked into the clinic unassisted and yet demonstrated profound muscle weakness when isolated testing was performed. This scenario is quite common.

Case 3. Fatigue Secondary to Muscle Weakness

The patient was a physical therapy student participating in the muscle testing laboratory. During testing it was noticed that he could not walk on his toes symmetrically, and on questioning he admitted that he had calf muscle fatigue after walking across campus which seemed to affect his ability to walk quickly. On further questioning, he reported a history of multiple ankle sprains on the left side, with the most recent being 6 months earlier while he was playing volleyball. Initially he treated the sprain with ice and compression and had limited his weight-bearing until the swelling decreased. He never sought the consultation of a physician or physical therapist after any of his sprains. It took several months for the ankle stiffness to resolve, and he reported there was some swelling after activity such as walking across campus. He was playing volleyball once again but did not feel he had regained his ability to jump, cut side to side, or go for a ball with confidence.

There was no ankle pain at examination, but there was limited range of motion at the end range of dorsiflexion, eversion, and inversion. Strength was evaluated using manual muscle testing. Manual muscle testing was chosen for the following reasons: the therapist can compare strength values side to side, the forces produced by the evertors and invertors are small enough to resist manually, and body-weight resistance is used to challenge the plantar flexors.

The standing plantar flexion test revealed his ability to rise 25 times on the unaffected ankle clearing at least 2 inches with each repetition (Grade 5). On the sprained side, he completed seven repetitions with difficulty before muscle fatigue occurred as evidenced by the inability to lift his heel the required 2 inches (Grade 4).

Inversion and eversion were then tested using manual resistance.

The unaffected side was tested first and was evaluated as Grade 5 in both movements secondary to a negative break test against maximum resistance. Strength on the affected side was Grade 5 for inversion but Grade 3 for eversion. It took minimal resistance before the fibularis longus and brevis (i.e., peroneal muscles) failed to hold against resistance. There was no pain with muscle resistance.

This case reflects a common finding: residual muscle strength deficits following what appears to be a simple injury. His involved plantar flexors were Grade 4, and his evertors were Grade 3. Given

his commonplace injury, he expected a complete return of strength and range and did not seek the services of a clinician. He could have gone through life unable to fully participate in sports at his level of inherent skill and strength. It was the serendipity of being a student in a clinical program that resulted in evaluation and subsequent treatment. How many other men and women are "getting by" with diminished strength following a simple injury?

Case 4. Muscle Weakness Following Nerve Injury

The patient is a 34-year-old male who was referred to the clinic because of weakness in his forearm, wrist, and hand. History taking revealed the patient was caught in the 2010 earthquake in Haiti and suffered a crush injury of the arm when a portion of a wall collapsed on it. He had open reduction internal fixation surgery to repair the crush damage to the radius and ulna, and his arm and forearm were in a cast for 3 months (due to a lack of orthopedic physicians). After cast removal, he was placed in a cast brace that permitted some movement at the elbow, wrist, and fingers. The patient wore the cast brace for approximately 4 more months again because of the inconsistency of medical personnel providing follow-up care. He had his first physical therapy visit 2 months after removal of the cast brace. At that time his fractures were healed and he was cleared for all resistance activities for the upper extremity including wrist and hand.

The patient complained of an inability to hold onto objects including a water glass. The patient's fingers were swollen and stiff but movement was observable toward finger closure, finger opening, and spreading the fingers a small distance (abduction). Thumb movement was minimal in all directions. Gross sensory testing revealed diminished sensation along the forearm over the muscle bellies of the wrist extensors and over the dorsum of the thumb. Sensation was also diminished on the thumb pad and over the skin of the thumb web.

The initial findings were severe muscle weakness following almost 1 year of reduced mobility; generalized hand/finger stiffness; reduced range of motion throughout the forearm, wrist, and hand; and diminished sensation at multiple sites. The therapist suspected a nerve injury and chose to do a manual muscle test to rule out or confirm nerve injury.

Establishing a strength and muscle involvement baseline was needed in this case. Muscle tests performed:

Elbow flexion and extension: To confirm that nerve damage is below the elbow.

Elbow flexion: Grade 5
Elbow extension: Grade 5

Radial nerve: Wrist extension (flexor carpi radialis, ulnaris, metatarsophalangeal (MP) extension, thumb MP, and interphalangeal (IP) extension).

Results

Wrist extension: Grade 4
Finger extension: Grade 2
Thumb (DIP and IP) extension: Grade 2
Thumb MP: Grade 2
Thumb IP extension: Grade 2

Median nerve: pronation, wrist flexion, MP flexion, proximal phalanges (PIP) flexion (flexor digitorum superficialis), distal phalanges (DIP) flexion (flexor digitorum profundus), thumb MP and IP flexion, thumb abduction (abductor longus and brevis tests) and thumb opposition.

Results

Wrist flexion: Grade 3
PIP flexion: Grade 2
DIP flexion: Grade 2
MP flexion: Grade 2

Thumb opposition: Grade 2
Thumb PIP flexion: Grade 2
Thumb adduction: Grade 2
Thumb IP flexion: Grade 2
Ulnar nerve: Finger abduction and adduction, thumb adduction.

Results

Finger abduction: Grade 2
Thumb abduction: Grade 2

Grip strength was 4 pounds as measured with a handheld dynamometer, barely enough to hold a glass of water.

It is not uncommon for physical therapists to diagnose unsuspected findings, and in this instance, it was incomplete radial and median nerve damage. The patient reported signs of recovery beginning to occur.

Manual muscle testing was ideal in this instance because there were small muscles involved where the therapist could apply appropriate resistances and easily position the limbs and segments. In addition, specific knowledge was needed to define muscle loss. Grip strength testing could not have provided the important insights gained through individualized muscle testing necessary to diagnose the nerve injury.

Case 5. Muscle Weakness Following Hip Surgery

The patient is a 78-year-old woman weighing 170 lb (BMI = 26.6) who broke her right hip after a fall from her bicycle. She had an open reduction, internal fixation of the hip 7 months ago and had physical therapy for 5 weeks immediately following the surgery in a long-term care setting. Now the patient is reluctant to return to road cycling for fear of falling, so elected to regain her fitness level by training on a stationary cycle. Immediately after beginning her stationary cycling, she found her right leg (affected side) would not perform as well as her left. Her complaint was "lack of push power" on the right and that her leg "wore out" in seconds rather than minutes. Her goal was to cycle vigorously for 30 minutes daily and take a brisk walk every other day.

A posterior approach that bisects the gluteus maximus and medius was performed for the fracture repair, affecting strength. Following surgery she was non–weight bearing for nearly 3 months and used a walker to ambulate. At month 4 she was permitted toe-touch ambulation and over the next few months progressed to walking with a single-point cane. Gait observation indicated a shorter stride length on the right and a gluteus medius limp that was masked by the cane. As soon as the patient placed the cane on her arm and attempted to walk unaided, her gluteus medius limp became evident and the short stride on the right became even shorter.

Given the age and sex of the patient and the likely muscles involved, a manual muscle test was selected for use. In addition, a single-limb leg press was used bilaterally to provide side-to-side comparisons. Two functional tests were utilized: the 30-second chair rise test, and the timed stair climb for one flight and the total number of consecutive flights. Manual muscle testing for the gluteus medius was performed side lying. The patient was unable to lift her involved side against gravity (Grade 2). Her uninvolved side was Grade 4. Manual muscle testing of the hip adductors, extensors, and internal and external rotators was performed, beginning with active range against resistance and then applying resistance, if successful, or changing the position to a Grade 2 if unsuccessful. Also tested were the muscles above and below the affected site, the knee flexors and extensors, and the core (abdominals, back extensors) because it is rare that weakness is present at one segment only. The modified plank position was used for the core muscles as the patient could not attain a full plank or perform a lateral plank.

Results

Core: Grade 3
Hip extensors: Grade 4 left, Grade 2 right

Hip abductors: Grade 4 left, Grade 2 right
Hip adductors: Grade 4 left, Grade 3 right
Internal rotation: Grade 4 left, Grade 4 right
External rotation: Grade 4 left, Grade 3 right
Knee flexion: Grade 4 left, Grade 4 right
Unilateral leg press: 140 pounds left, 45 pounds right
Chair rises: Without using the chair arms, the patient was able to do one chair rise and this one repetition required multiple attempts.
Stair climb: The patient ascended one flight of nine stairs up and down in 39 seconds.

This case illustrates the fairly classic scenario of patient discharge long before rehabilitation is complete. Fortunately, the patient had a long exercise history and her current state of weakness and reduced function were unacceptable to her. Thus she was a prime candidate for a home program of strengthening and endurance work and a continuing community exercise program.

Case 6. Muscle Weakness Following Childbirth

The patient gave birth to her second child 2 years ago. Postpartum exercises were never initiated, and she had no history of engaging in any routine physical activity other than childcare. Now she is having difficulty with urine leakage when laughing, coughing, and lifting her toddler. The stress incontinence prompted her to seek help.

Muscles of the pelvic floor and abdomen elongate enormously to accommodate pregnancy and childbirth. In many women the stretched musculature fails to return to its prepartum strength and length. This pelvic floor/abdominal weakness scenario is especially likely in women who have had multiple births, particularly if they did not perform postpartum exercises.

For this woman, manual muscle testing of the abdominals and pelvic floor was chosen because these muscles are often found to be weak following childbirth. Muscle testing revealed the following.

Abdominal curl: seven repetitions with difficulty
Prone plank: 3 seconds
Pelvic floor (manual test): Grade 3

In summary, childbirth weakened the pelvic floor and abdominal musculature. Even though this weakness is present in nearly all women after delivery, too few are counseled to perform pelvic floor exercises or strengthen abdominals. If the condition persists, urinary incontinence is likely. Standard muscle testing techniques were used to identify weakness.

References

1. Lunsford BR, Perry J. The standing heel-rise test for ankle plantar flexion: criterion for normal. *Phys Ther*. 1995;75:694–698.
2. Jan MH, Chai HM, Lin YF, et al. Effects of age and sex on the results of an ankle plantarflexor manual muscle test. *Phys Ther*. 2005;85:1078–1084.