
CHAPTER 9

Handheld Muscle Dynamometry

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Introduction

Handheld dynamometry (HHD), also referred to as handheld myometry, is a manual muscle testing procedure by which a dynamometer is held in the hand of an examiner to quantitatively measure the strength of specific muscle actions of the limbs or trunk. Essentially, it is an extension of the human hand. The handheld dynamometer comes with different pads to be used for different body segments. HHD measures force on a continuous scale in Newtons (N), pounds (lb), or kilograms (kg) from 3.6 N up to 1320 N (0.2 to 300 lb), depending on the device. HHD should not be confused with grip strength dynamometry (see [page 218](#)) in which an instrument held in the hand of a patient is used to measure that patient's hand-grip strength.

Research published over the past 100 years describes the use of at least a dozen different handheld dynamometers.¹ Although handheld dynamometers are commonly used in research, they are less commonly used in the clinic, perhaps because the HHD technique is not routinely taught in entry-level programs. However, HHD has been used in a variety of settings that reflect the scope of physical therapist practice such as acute care,² inpatient rehabilitation,^{3,4} home care,⁵ and outpatient.⁶

Handheld dynamometers are accurate, easy to use, portable, and afford an objectivity that is lacking in manual muscle testing (MMT). The continuous scale used in HHD allows the identification of subtle differences in side-to-side comparisons and avoids the ceiling effect of MMT. HHD is also more responsive, making it possible to discern changes in strength within Grades 4 and 5. However, many of the issues and limitations of MMT discussed in [Chapters 1 and 2](#) are relevant to the application of HHD. The reader is referred to these chapters to review the limitations of MMT and to extend the recommendations for enhancing the reliability of MMT to HHD, recognizing that the same procedures apply to HHD. The reader is reminded that HHD values are influenced by the tester's strength, position, ability to stabilize the body segment and the technique used. Large muscle forces (over 250 N) may not be accurate due to stabilization and tester strength issues.⁷ The inability of some handheld dynamometers to record the high forces generated by strong

muscles (e.g., quadriceps and plantar flexors), lack of clear meaning of the scores, and the lack of standardization of positions are additional limitations of HHD.

Clinimetric Properties

The clinimetric properties of strength measures obtained by HHD have been researched extensively over the past few decades. Research on HHD reveals conflicting results for both test-retest and intertester reliability, in part because of the methodological quality of studies and lack of standardization of method (e.g., lack of stabilization, patient position, rate of force applied, use of make or break tests).^{8,9} Reliability tends to be lower when stronger actions, such as knee extension or plantar flexion, stronger patients, or weaker testers are involved.¹⁰⁻¹³

A systematic review of the intraexaminer reliability of HHD measurements obtained from the upper extremity demonstrated acceptable intra-rater and inter-rater reliability (ICC > 0.90) for only elbow flexion and extension;⁸ however, subsequent studies show similar intra-rater and inter-rater reliability (ICC > 0.90) for shoulder internal and external rotation tested in the 0 degrees and 90–90 shoulder-elbow position in sitting, prone and supine.^{14,15} Strength measurements are internally consistent when performed by a tester with adequate strength.¹⁶ Intersession reliability is better than intrasession reliability.^{8,17} Unfortunately, standardization of position and method is lacking in HHD; therefore the reliability demonstrated in these studies may not necessarily be applied to the positions described in this chapter.

The validity of HHD is supported by considerable research. Specifically, correlations between measurements obtained by HHD and measurements obtained by isokinetic dynamometry support the criterion validity of HHD.⁹ Convergent validity is supported by correlations between lower limb strength measured by HHD and performance of activities such as dressing, toileting and transferring,¹⁸ bed mobility,¹⁹ sit-to-stand,^{3,20} level ground ambulation,^{21,22} and stair negotiation.²³ Known groups validity is upheld by differences in the dynamometrically measured strength of normal adults and adults with pathologies and problems as diverse as renal failure,²¹ stroke,²⁴ osteoporosis,²⁵ diabetes,²⁶ osteoarthritis,²⁷ dementia,¹⁸ and fear of falling.^{27,28}

The responsiveness of HHD has been described mostly through reporting of minimal detectable change.^{16,29} Responsiveness is variable and is affected by HHD methods. Generally, a change of greater than 22 N in the upper extremity must be attained for confidence in a true difference.^{15,30} Minimal clinically important differences in force measured using HHD are lacking.

Normative reference values have been published for dynamometrically obtained measures of upper and lower limb strength.^{7,31-37} These norms are limited by the positions and type of dynamometer used and the use of make or break tests. Nevertheless, they provide some indication of what might be expected from healthy adults.

General Procedures

The tests described in this chapter use the same manual muscle testing positions described elsewhere in this book, and thus the same testing procedures are followed. First, the position of the patient is described. Then the patient is asked to perform the test action to assess the quality and quantity of the action and to determine if application of resistance is appropriate (e.g., in the presence of pain or inflammation). Although HHD may be used on a muscle action that does not produce full range, it is important to discern what limitations prevent full range such as weakness, joint restrictions, or pain. If weakness is below a Grade 3 (i.e., the patient cannot tolerate any resistance other than gravity), HHD may not be practical. Next, appropriate stabilization is applied and is a critical element in HHD testing. The assistance of another person may be needed if the therapist suspects the patient's muscle action could overcome the therapist's strength or adequate stabilization cannot be achieved without extra help. Once adequate stabilization is achieved, place the HHD on the body segment and ask the patient to push or pull against the HHD with maximum effort. This effort should occur within 2 to 5 seconds adhering to the procedures outlined on [page 309](#). The use of a break test elicits a slightly stronger and eccentric contraction³⁷ than a make test and thus is used in this text, similar to the recommended procedure for MMT. However, there may be times when a make test is more appropriate (e.g., in the presence of joint instability, patient cooperation, pain). To enhance reliability, a monotone command such as “push, push, push” is provided. At the completion of the effort, peak force is read from the dynamometer. Although a single effort may suffice in the experienced clinician,³⁸ a second or third trial should be conducted for the inexperienced therapist and patient. If multiple efforts are attained, the tester can choose

whether to average the results, using the highest or lowest value. Allow a rest of at least 30 seconds between efforts. Scoring is recorded in Newtons, rather than as muscle grades.

Testing Specific Actions

Various methods of testing over 25 different actions of the limbs and trunk using HHD have been described in the literature. Procedures vary, revealing a lack of standardization. Therefore, we have chosen the standard muscle testing positions described in this book, which are known to be valid testing positions. Consistent positions may encourage adoption and broader use, especially as validity studies on these positions are published. The therapist should review the helpful hints for each muscle action described in previous chapters ([Box 9.1](#)).

Box 9.1

Muscle Actions

- Shoulder flexion
- Shoulder extension
- Shoulder abduction
- Shoulder external rotation
- Shoulder internal rotation
- Elbow flexion
- Elbow extension
- Wrist extension
- Hip abduction
- Hip flexion
- Hip extension
- Hip flexion
- Hip external rotation
- Hip internal rotation
- Knee extension
- Knee flexion
- Foot dorsiflexion and inversion

Reference Scores

The lack of standardization of HHD makes the interpretation of normative scores difficult. In this chapter, we have used normative data from studies using positions similar to the standard MMT positions. These positions often require some dynamic stabilization that may influence the muscle force generated. The reader is cautioned to analyze any differences in scores achieved with normative scores achieved in different positions. We have used normative scores for the dominant upper limb. The reader should be aware that in normal adults without pain or muscle disease, the stronger side does not exceed the weaker one by more than 22%.⁷ When normative scores do not exist for the MMT positions, we have used studies of large samples. Results from break tests are included whenever available. Because of the variability of normative scores across studies, we have opted to use mean scores and standard deviations using decade data. If more precise scores are desired, the reader is encouraged to read the referenced study. The mean score should give the beginner user an idea of approximate values for specific muscle actions. Scores are always recorded in Newtons. When normative scores were recorded in Kg, they were converted to Newtons, by multiplying $\text{Kg} \times 9.8$. The reader is also cautioned about placing undue emphasis on values and results exceeding 250 N, because 250 N most likely exceeds the force necessary for the performance of most functional tasks⁷ and may have reduced reliability as compared to lower values. Additionally, most therapists will not be able to effectively stabilize or resist muscle forces exceeding 250 N. Examples are the knee extensors and plantar flexors.

Shoulder Flexion

(Anterior deltoid, Rotator cuff, Clavicular portion of pectoralis major, and Coracobrachialis)

Position of Patient:

Short sitting with arms at sides, elbow slightly flexed, forearm pronated.

Instructions to Therapist:

Stand at the test side. Ask the patient to raise the arm forward to shoulder height (see [Fig. 5.50](#) on [page 120](#)). If application of resistance is appropriate, proceed to test. Position the patient's arm in 90° of flexion with the forearm in neutral rotation and the arm in the sagittal plane. Ask the patient to hold the position. Place the hand with the handheld dynamometer over the distal humerus just above the elbow. The other hand stabilizes the shoulder ([Fig. 9.1](#)). Resistance is given in a downward direction.



FIGURE 9.1

Test:

The patient holds the shoulder in 90° of flexion without rotation or horizontal movement (see [Fig. 9.1](#) and [Fig. 5.50](#) on [page 120](#)). The scapula should be allowed to abduct and upwardly rotate.

Instructions to Patient:

“Hold your arm. Don't let me push it down. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a break test in sitting³⁵:

Mean for 20- to 59-year-old men = 203.4 (43.1)

Mean for 20- to 59-year-old women = 102.6 (35.6)

Shoulder Extension

(*Posterior deltoid, Latissimus dorsi, Teres major, Long head of triceps*)

Position of Patient:

Prone with arms at sides and shoulder internally rotated (palm up). Head turned toward the side being tested (see [Fig. 5.56](#) on [page 124](#)).

Instructions to Therapist:

Stand at the test side. Ask the patient to lift the arm as high as possible. If application of resistance is appropriate, proceed to test. Position the arm in full extension. Ask the patient to hold the position. Place the hand with the handheld dynamometer over the posterior arm just above the elbow. Stabilization is provided by the prone position. Resistance is applied in a downward direction ([Fig. 9.2](#)).

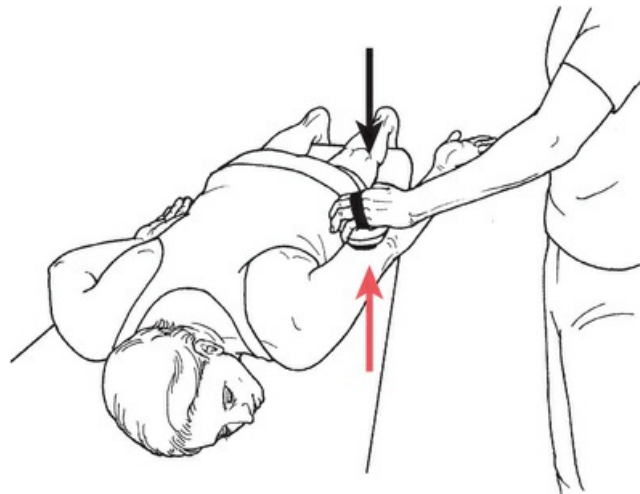


FIGURE 9.2

Test:

Patient holds the arm off the table, with the elbow straight (see [Fig. 5.58](#) on [page 124](#)).

Instructions to Patient:

"Hold your arm. Don't let me push it down. Hold ... hold ... hold."

Reference Scores

Normative scores with standard deviations below are for a break test in the sitting position³⁵:

Mean for 20- to 59-year-old men = 162.9 (41.7)

Mean for 20- to 59-year-old women = 80.9 (31.3)

Shoulder Abduction

(Middle deltoid and Supraspinatus)

Position of Patient:

Short sitting with arm at side and elbow slightly flexed.

Instructions to Therapist:

Stand behind the patient. Ask the patient to lift the arm out to the side to shoulder level with the forearm in neutral, thumb pointed up. If application of resistance is appropriate, proceed to test. Position the patient's arm in 90° of abduction in the frontal plane. Ask the patient to hold the position. Place the hand with the handheld dynamometer over the arm, just above the elbow. Resistance is given in a downward direction. Stabilize at the top of the shoulder, if needed ([Fig. 9.3](#)).

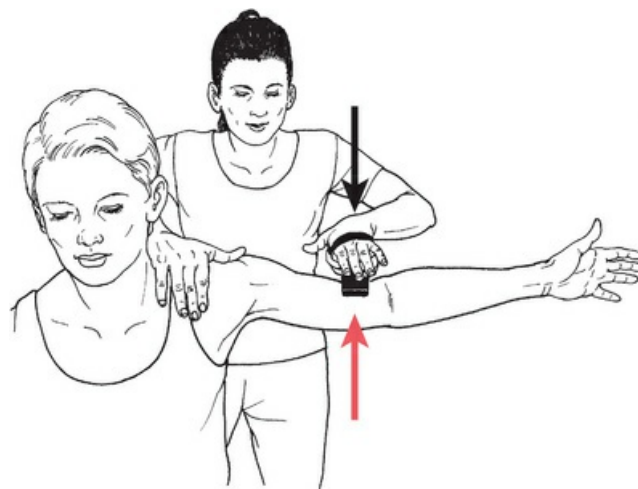


FIGURE 9.3

Test:

Patient abducts the arm to 90°, with the elbow straight and forearm pronated (see [Fig. 5.65](#) on [page 128](#)).

Instructions to Patient:

“Hold your arm. Keep your elbow straight. Don't let me push it down. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a break test in sitting³⁵:

Mean for 20- to 59-year-old men = 167.0 (47.2)

Mean for 20- to 59-year-old women = 84.4 (31.8)

Shoulder External Rotation

(*Infraspinatus and Teres minor*)

Position of the Patient:

Short sitting, with elbow flexed to 90° and forearm in neutral.

Instructions to Therapist:

Stand in front of or sit beside the patient. Ask the patient to move the forearm away from the trunk (see Fig. 5.86 on page 141). If application of resistance is appropriate, proceed to test. Position the patient's arm in neutral shoulder rotation with the elbow flexed to 90°. Ask the patient to hold the position. Place the hand with the handheld dynamometer over the dorsal (extensor) surface of the forearm, just proximal to the wrist. The other hand stabilizes the medial aspect of the elbow. Resistance is given with a medially directed force on the outside of the forearm. Because this is not an antigravity position, maximal resistance should be used, if appropriate (Fig. 9.4).

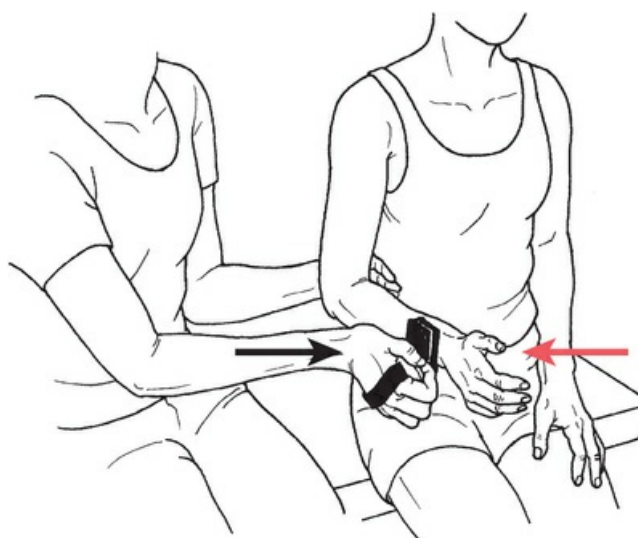


FIGURE 9.4

Test:

Patient holds the shoulder and forearm in neutral position against a medially directed force.

Instructions to Patient:

"Push your forearm against my hand. Hold it. Don't let me move it. Hold ... hold ... hold."

Reference Scores

Normative scores with standard deviations below are for a break test in sitting³⁵:

Mean for 20- to 59-year-old men = 107.4 (31.5)

Mean for 20- to 59-year-old women = 59.2 (22.9)

Normative scores for a make test in sitting³¹

Mean for 20- to 59-year-old men = 134.7 (39.6)

Mean for 20- to 59-year-old women = 82.2 (20.9)

Mean for 60- to 80+-year-old men and older = 96.7 (25.3)

Mean for 60- to 80+-year-old women and older = 63.3 (19.2)

Shoulder Internal Rotation

(Subscapularis)

Position of Patient:

Short sitting with elbow flexed to 90° and forearm in neutral.

Instructions to Therapist:

Stand in front of or sit beside the patient and ask the patient to move the forearm toward the trunk (see Fig. 5.94 on page 146). If application of resistance is appropriate, proceed to test. Position the shoulder in neutral rotation with the elbow flexed to 90°. Ask the patient to hold the position. Place the hand with the handheld dynamometer over the volar (flexor) surface of the forearm, just proximal to the wrist. The other hand stabilizes the lateral aspect of the elbow with one hand. Resistance is given in a lateral direction away from the trunk (Fig. 9.5). Because this is not an antigravity position, maximal resistance should be used, if appropriate.

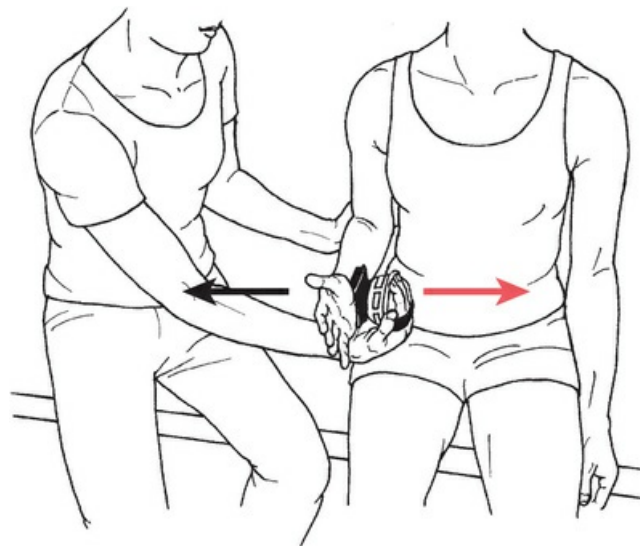


FIGURE 9.5

Test:

Patient holds the shoulder and forearm in neutral against a laterally directed force.

Instructions to Patient:

“Pull your forearm in toward your stomach. Hold it. Don't let me move it. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a break test in sitting³⁵:

Mean for 20- to 59-year-old men = 112.7 (44.0)

Mean for 20- to 59-year-old women = 52.4 (22.1)

Elbow Flexion

(Biceps, Brachialis, and Brachioradialis)

Position of Patient:

Short sitting with arms at sides. Elbow flexed with forearm supinated.

Instructions to Therapist:

Stand in front of the patient toward the test side. Ask the patient to bend the elbow. If testing is appropriate, proceed to test. Position the patient's elbow in 120° of flexion with the shoulder in the sagittal plane and forearm in supination (Fig. 9.6). Ask the patient to hold the position. Place the hand holding the handheld dynamometer over the volar (flexor) surface of the forearm proximal to the wrist in the direction of extension (Fig. 9.7). The other hand provides stabilization on the anterior surface of the shoulder. Resistance is given in a downward direction toward elbow extension.



FIGURE 9.6



FIGURE 9.7

Test:

Patient holds the elbow position.

Instructions to Patient:

“Hold your elbow. Don't let me move it. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a break test in sitting³⁵:

Mean for 20- to 59-year-old men = 287.5 (83.8)

Mean for 20- to 59-year-old women = 163.3 (49.6)

Normative scores for a make test in supine³¹:

Mean for 60- to 80+-year-old men and older = 209.4 (48.4)

Mean for 60- to 80+-year-old women and older = 129.7 (33.9)

Elbow Extension

(*Triceps brachii*)

Position of Patient:

Prone on the table with the patient's head facing toward the test side. The patient starts the test with the shoulder in 90° of abduction and the elbow flexed to 90° and in neutral rotation with the thumb down. The forearm hangs over the side of the table (see Fig. 5.113 on page 157).

Instructions to Therapist:

Stand to the side of the patient. Ask the patient to straighten the elbow. If the application of resistance is appropriate, proceed to test. Position the elbow in 160° (not full extension to avoid hyperextension or “locking”). Ask the patient to hold the position. Place the hand with the handheld dynamometer on the distal surface of the extended forearm just proximal to the wrist. Provide support of the arm just above the elbow with one hand. No stabilization is needed in this position. Resistance is applied in a downward direction (Fig. 9.8).



FIGURE 9.8

Test:

Patient holds the position of elbow extension.

Instructions to Patient:

“Hold it. Don't let me bend your elbow. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a break test in sitting³⁵:

Mean for 20- to 59-year-old men = 184.2 (46.7)

Mean for 20- to 59-year-old women = 120.0 (34.3)

Normative scores below are for a make test in supine³¹

Mean for 60- to 80+-year-old men and older = 162.1 (36.8)

Mean for 60- to 80+-year-old women and older = 102.8 (25.3)

Wrist Extension

(*Extensor carpi radialis longus*, *Extensor carpi radialis brevis*, and *Extensor carpi ulnaris*)

Position of Patient:

Short sitting with elbow flexed and forearm supported on a table. The forearm is fully pronated.

Instructions to Therapist:

Sit or stand at a diagonal in front of the patient. Ask the patient to lift the hand. If resistance is appropriate, proceed to test. Position the wrist in full extension with forearm fully pronated. Ask the patient to hold the position (Fig. 9.9). Place the hand holding the handheld dynamometer over the dorsal (extensor) surface of the hand. Stabilization is provided by the resting position of the forearm on the table. Resistance is given in a downward direction (Fig. 9.10)

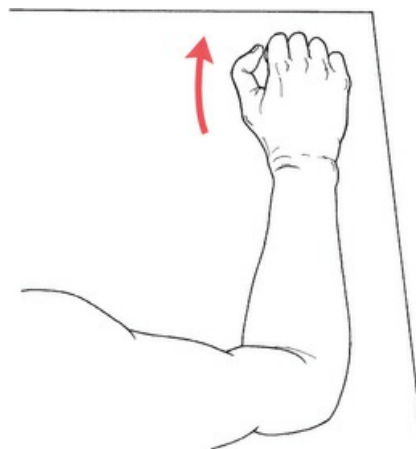


FIGURE 9.9

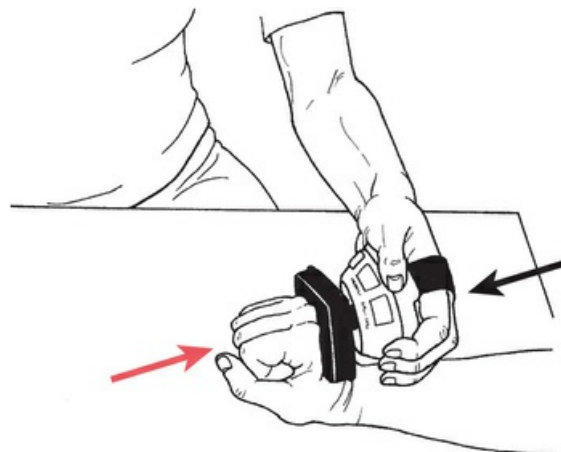


FIGURE 9.10

Test:

For the combined test of the three wrist extensor muscles, the patient holds full wrist extension. Do not permit extension of the fingers.

Instructions to Patient:

“Hold your wrist. Don't let me push it down. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a break test in sitting³⁵.

Mean for 20- to 59-year-old men = 186.1 (48.8)

Mean for 20- to 59-year-old women = 107.9 (41.2)

Hip Flexion

(*Psoas Major and Iliacus*)

Position of Patient:

Short sitting with thighs fully supported on the table and legs hanging over the edge. The patient may use the arms to provide trunk stability by grasping the table edge or with hands on the table at each side.

Instructions to Therapist:

Stand next to the limb being tested. Ask the patient to lift the thigh off the table (see Fig. 6.5 on page 228). If the application of resistance is appropriate, proceed to test. Position the hip in maximum hip flexion. Ask the patient to hold the position. Place the hand holding the handheld dynamometer over the distal thigh just proximal to the knee joint. Stabilization is provided by the patient's arms. Resistance is given in a downward direction (Fig. 9.11).



FIGURE 9.11

Test:

Patient holds the hip at the end range, clearing the table and maintaining neutral rotation.

Instructions to Patient:

“Sit tall and hold your thigh up. Don't let me push it down. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a make test in supine³¹:

Mean for 20- to 59-year-old men = 247.0 (17.0)

Mean for 20- to 59-year-old women = 80.0 (22.0)

Normative scores below are for a break test in supine position³⁴:

Mean for 60- to 69-year-old men = 247.0 (17.0)

Mean for 60- to 69-year-old women = 167.0 (20.0)

Hip Extension

(*Gluteus maximus and hamstrings*)

Test is for the aggregate of all hip extensor muscles

Position of Patient:

Prone. Arms may be at the side of the body or abducted to hold the sides of the table. (Note: If there is a hip flexion contracture, immediately go to the test described for hip extension modified for hip flexion tightness [see Fig. 9.13].)

Instructions to Therapist:

Stand at the level of the pelvis on the side of the limb to be tested. (Note: The figure shows the therapist on the opposite side to avoid obscuring activity.) Ask the patient to lift the leg off the table as high as possible, while keeping the knee straight and the pelvis stabilized against the table. Stabilization can be applied over the gluteus maximus to keep the pelvis from rising, if needed. If the application of resistance is appropriate, proceed to test. Position the leg in full extension with no pelvic rotation. Ask the patient to hold the position. Place the hand holding the handheld dynamometer on the posterior thigh just above the knee. Resistance is applied in a downward direction (Fig. 9.12).

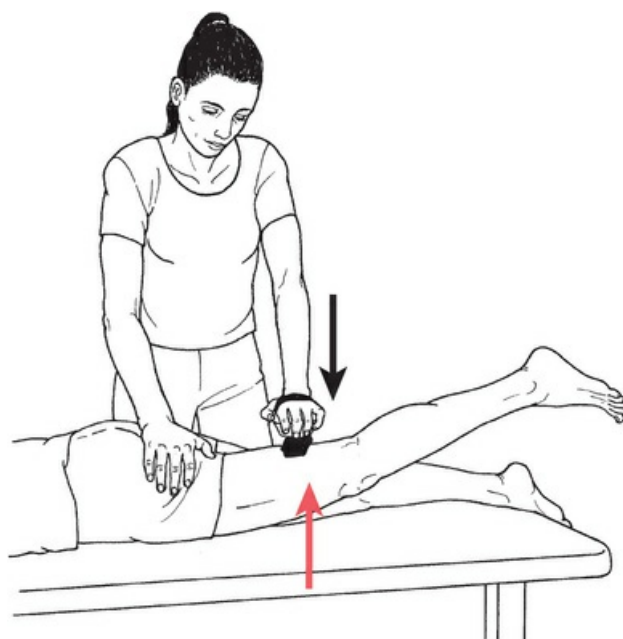


FIGURE 9.12

Test:

Patient holds the thigh up off table in the maximum available range.

Instructions to Patient:

"Lift your leg off the table as high as you can. Don't bend your knee. Hold it. Don't let me push it down. Hold ... hold ... hold."

Reference Scores

Not available.

Hip Extension Tests Modified for Hip Flexion Tightness

Position of Patient:

Patient stands with hips flexed and leans over the table so that the anterior superior iliac spine (ASIS) is “hooked” on the end of the table. The arms are used to “hug” the table for support. The knee of the nontest limb should be flexed to allow the test limb to rest on the floor at the start of the test.

Instructions to Therapist:

Stand at the side of the limb to be tested. (Note: The figure shows the therapist on the opposite side to avoid obscuring the test position.) Ask the patient to lift the leg toward the ceiling. If the application of resistance is appropriate, proceed to test. Place the hand holding the handheld dynamometer over the posterior thigh just above the knee. The opposite hand stabilizes the pelvis laterally to maintain hip and pelvis posture. Resistance is applied downward, toward the floor (Fig. 9.13),

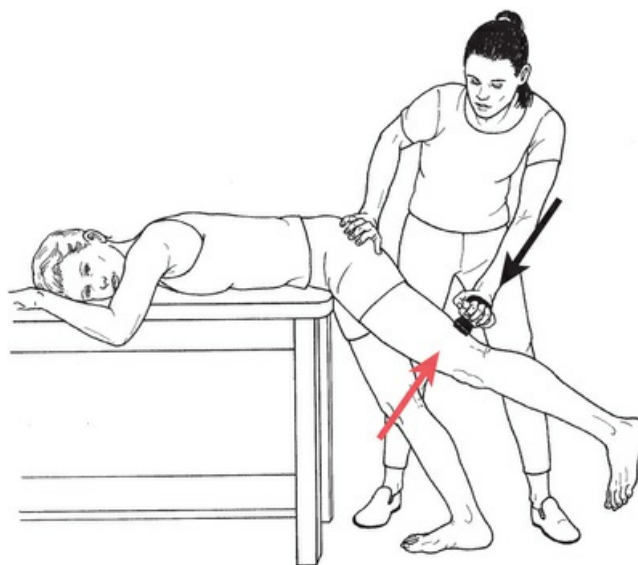


FIGURE 9.13

Test:

Patient holds the hip in full extension.

Instructions to Patient:

“Lift your leg off the floor as high as you can. Keep your knee straight. Don't let me push it down. Hold ... hold ... hold.”

Reference Scores

Not available

Hip Abduction

(*Gluteus medius and gluteus minimus*)

Position of Patient:

Side-lying with test leg uppermost. The patient's hip is slightly extended beyond the midline and the pelvis rotated slightly forward (see Fig. 6.36 on page 245). Lowermost leg is flexed for stability.

Instructions to Therapist:

Stand behind the patient. Ask the patient to lift the leg as high as possible with verbal cues as needed to prevent the leg from rotating and the hip from flexing. The raised ankle should be in line with the pelvis. Stabilization on the hip may be needed. If the application of resistance is appropriate, proceed to test. Position the leg into full abduction with the ankle in line with the iliac crest. Place the hand holding the handheld dynamometer just proximal to the knee. Resistance is applied in a downward direction (Fig. 9.14).



FIGURE 9.14

Test:

Patient holds the abducted hip at the end of the available range of motion without flexing the hip or rotating it in either direction.

Instructions to Patient:

“Hold your leg. Don't let me push it down. Hold ... hold ... hold.”

Reference Scores

Side-lying hip abduction using a strap to fix the handheld dynamometer to the distal thigh (not shown) has a high reliability (ICC = 0.95)²³ and may improve scores and reliability. Widler³⁹ found a 30% higher force value in the side-lying position, using a fixed dynamometer as compared to supine using a fixed dynamometer. However, normative scores do not exist for the side-lying position in large sample sizes.

Normative scores with standard deviations below are for a make test in the supine position.³¹

Mean for 20- to 59-year-old men = 170.7 (43.9)
Mean for 20- to 59-year-old women = 113.1 (32.4)
Mean for 60-year-old men and older = 124.8 (32.8)
Mean for 60-year-old women and older = 83.8 (23.5)

Hip External Rotation

(*Obturator internus and externus, Gemelli superior and inferior, Piriformis, Quadratus femoris, Gluteus maximus [posterior]*)

Position of Patient:

Short sitting with thighs fully supported on the table and legs hanging over the edge. (Trunk may be supported by placing hands flat or fisted at the patient's side on the table).

Instructions to Therapist:

Sit on a low stool or kneel beside limb to be tested. Ask the patient to turn the leg in toward the other leg without moving the thigh (see [Fig. 6.67](#) on [page 259](#)).

If the application of resistance is appropriate, proceed to test. Position the leg into neutral rotation. Place the hand with the handheld dynamometer on the medial aspect of the ankle just above the malleolus. Extra padding may be needed under the dynamometer for the patient's comfort (not shown). The other hand, which will offer counterpressure, is contoured over the lateral aspect of the distal thigh just above the knee. Resistance is applied as a laterally directed force at the ankle. Stabilization is provided in a medially directed force at the knee counteracting the resistance provided at the ankle. The two forces are applied in counter-directions for this rotary motion ([Fig. 9.15](#)).



FIGURE 9.15

Test:

Patient attempts to externally rotate the hip against maximum resistance.

Instructions to Patient:

“Hold your leg. Don't let me turn your leg out. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a make test in sitting³¹:

Mean for 20- to 59-year-old men = 169.4 (45.8)

Mean for 20- to 59-year-old women = 100.7 (29.1)
Mean for 60- to 80+-year-old men and older = 125.5 (33.9)
Mean for 60- to 80+-year-old women and older = 76.3 (23.7)

Hip Internal Rotation

(*Glutei minimus and medius; Tensor fasciae latae*)

Position of Patient:

Short sitting with thighs fully supported on the table and legs hanging over the edge. (Trunk may be supported by placing hands flat or fisted at the patient's sides on the table.)

Instructions to Therapist:

Sit or kneel in front of the patient. Ask the patient to move the lower leg out, away from the other leg without letting the thigh move (see Fig. 6.72 on page 262). If application of resistance is appropriate, proceed to test. Position the leg in mid position between internal and external rotation. Place the hand with the handheld dynamometer on the lateral surface of the ankle just above the malleolus. The other hand, which offers counterpressure, is contoured over the medial surface of the distal thigh just above the knee. Resistance is given in a medially directed force at the knee as a counterforce (Fig. 9.16).



FIGURE 9.16

Test:

The patient holds the mid-range of hip rotation against resistance.

Reference Scores

Normative scores with standard deviations below are for a make test in sitting³¹:

Mean for 20- to 59-year-old men = 217.0 (62.4)

Mean for 20- to 59-year-old women = 136.1 (44.0)

Mean for 60- to 80+-year-old men and older = 169.7 (55.0)

Mean for 60- to 80+-year-old women and older = 108.4 (33.8)

Knee Flexion

(All hamstring muscles)

Position of Patient:

Prone with legs straight and toes hanging over the edge of the table. A towel roll placed just above the knee may make this position more comfortable.

Instructions to Therapist:

Stand next to the limb to be tested. Ask the patient to flex the knee as far as possible (see [Fig. 6.81](#) on [page 267](#)). If the application of resistance is appropriate, proceed to test. Position the knee in about 45° of knee flexion (mid-range). Ask the patient to hold the position. Place the hand holding the handheld dynamometer on the posterior surface of the leg just above the ankle. Extra padding under the handheld dynamometer may be needed. The other hand provides stabilization over the hamstring tendons on the posterior thigh (optional). Firm pressure with this hand may offset any cramping of the hamstring muscles. Resistance is applied downward in the direction of knee extension ([Fig. 9.17](#)).



FIGURE 9.17

Test:

Patient holds the knee in 45° of knee flexion.

Instructions to Patient:

"Hold your leg. Don't let me straighten your knee. Hold ... hold ... hold."

References Scores

Normative scores not available.

Knee Extension

(*Quadriceps femoris*)

Patient Position:

Short sitting. Place either a wedge or a hand under the patient's distal thigh to cushion the thigh from the surface. The patient's hands rest on the table on either side of the body for stability or may grasp the table edge. The patient should be allowed to lean backward slightly to relieve hamstring muscle tension. Do not allow the patient to hyperextend the knee.

Instructions to Therapist:

Stand at the side of the limb to be tested. Ask the patient to straighten the knee. If the application of resistance is appropriate, proceed to test. Position the knee in approximately 10° to 15° of knee flexion (avoiding hyperextension or the ability of the patient to “lock” the knee). Ask the patient to hold the position. Place the hand holding the handheld dynamometer over the anterior surface of the distal leg just above the ankle. Padding under the handheld dynamometer may be necessary for patient comfort. Resistance is applied in a downward direction toward the floor with both hands if necessary (Fig. 9.18).

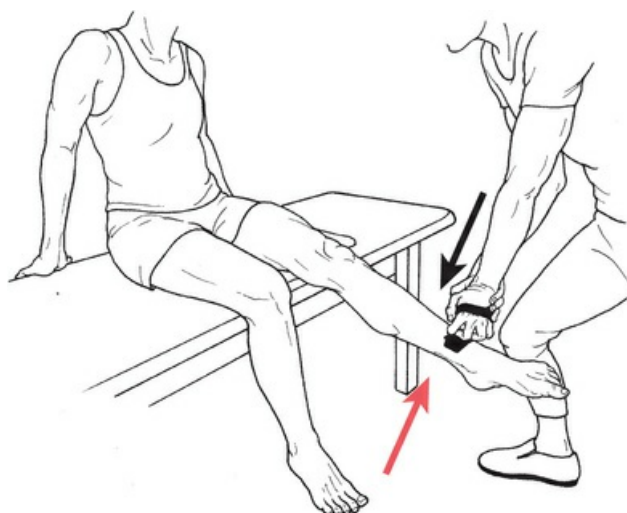


FIGURE 9.18

Very often the patient's strength can overpower the therapist's strength during this muscle action. To prevent the patient's pelvis from rising (a common occurrence in a maximum effort test), the patient may be secured to the testing surface by a belt or strap.

Test:

Patient holds the knee in 10° to 15° of knee flexion.

Instructions to Patient:

“Hold your leg. Don't let me bend it. Hold ... hold ... hold.”

Reference Scores

Normative scores with standard deviations below are for a make test in sitting³⁶:

- Mean for 20- to 59-year-old men = 551.2 (86.1) (20 subjects surpassed 650 N)
- Mean for 20- to 59-year-old women = 398.7 (94.48) (1 subject surpassed 650 N)
- Mean for 60- to 79-year-old men = 386.9 (94.2)
- Mean for 60- to 79-year-old women = 241.9 (81.6)

Foot Dorsiflexion and Inversion

(*Tibialis anterior*)

Position of Patient:

Supine with the foot at the end of the table.*

Instructions to Therapist:

Stand at the foot of the table with the patient's heel resting on the table. Ask the patient to bring the foot up and in, toward the body. If the application of resistance is appropriate, proceed to test. Position the foot in maximum dorsiflexion. Ask the patient to hold the position. Place the hand holding the handheld dynamometer over the dorsum of the foot just proximal to the toes. No stabilization is needed in this position. Resistance is given by pulling down and out (Fig. 9.19). You may need to use both hands to appropriately resist this potentially strong muscle action.



FIGURE 9.19

Test:

Patient holds the position of full ankle dorsiflexion and inversion, keeping toes relaxed.

Instructions to Patient:

"Bring your foot up and in. Hold it. Don't let me pull it down. Hold ... hold ... hold."

Reference Scores

Normative scores with standard deviations below are for a make test in long sitting³¹:

Mean for 20- to 59-year-old men = 224.6 (48.2)

Mean for 20- to 59-year-old women = 166.5 (41.6)

Mean for 60- to 80-year-old men and older = 173.3 (44.0)

Mean for 60- to 80-year-old women and older = 131.5 (38.9)

Normative scores with standard deviations below are for a break test in supine³⁴:

Mean for 20- to 59-year-old men = 279.3 (23.0)

Mean for 20- to 59-year-old women = 240.3 (26.0)
Mean for 60- to 69-year-old men = 266.0 (30.0)
Mean for 60- to 69-year-old women = 216.0 (31.0)

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*We recommend the supine position, rather than an antigravity position, because of the mechanical advantage afforded the therapist in providing adequate resistance to this very strong muscle.