MUSCLE EXTENSIBILITY TESTING FOR THE LOWER EXTREMITY—A REVIEW FOR THE PERSONAL TRAINER

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Lower extremity muscle extensibility deficits can affect joint mobility and be a problem in the active population by increasing injury risk (6). Researchers have reported a correlation between muscle extensibility deficits and injuries to the hamstrings (17), quadriceps (8,27), and Achilles tendon (15,18). The personal trainer may need to address muscle extensibility deficits with their clients in order to decrease the likelihood of injury (4,6).

One way personal trainers can determine if a client has muscle extensibility deficits is through muscle extensibility tests. These tests are often used to screen clients and confirm the presence of extensibility deficits prior to prescribing a flexibility and mobility program (6,7). Understanding specific tests may help the personal trainer to better identify deficits and focus the intervention programs to address those issues. The purpose of this article is to provide a review of common muscle extensibility tests of the lower extremity.

MUSCLE EXTENSIBILITY TESTS

The following sections discuss specific muscle extensibility tests for the lower extremity that can be easily performed in a short amount of time with little to no equipment or preparation time. The term "muscle extensibility" refers to the muscle's ability to lengthen or stretch (19). Muscle extensibility is needed for overall flexibility, which includes the ability of the body tissues (e.g., muscles and connective tissues) to lengthen appropriately to allow the joint/s to move through a full range of motion (26). "Mobility" is another term used to describe how the joint/s can freely move during motion (19). The personal trainer should consider that several related terms exist that may be referring to the same observable concept. The tests described in the subsequent sections have been classified as muscle extensibility tests in the research. A measurement device, such as a goniometer, can be used to measure the degrees of motion for all the tests discussed. Some examples will be provided in the following sections.

ILIOPSOAS AND RECTUS FEMORIS

This section presents two muscle extensibility tests for the iliopsoas and rectus femoris muscles. The Duncan-Ely, or prone knee flexion, test can be performed passively by the personal trainer or actively by the client (21). The test assesses rectus femoris length (16,21). The modified Thomas test is a passive test administered by the client (22). The test measures both iliopsoas and rectus femoris muscle extensibility. The personal trainer must ensure that the client maintains a stable pelvis for all tests.

DUNCAN-ELY TEST (PRONE KNEE FLEXION)

Rationale: Passive test

Client Position: Prone on table with legs together and both knees extended.

Personal Trainer Position: Standing next to the test leg.

Passive Procedure: The personal trainer grasps the test leg above the ankle and passively flexes the knee to a maximum pain free limit. The contralateral hip and knee are kept flat on the table (Figure 1).

Active Procedure: The client actively flexes the knee to a maximum pain free limit.

Interpretation: If the test hip rises as the knee is flexed, that indicates decreased muscle extensibility. No movement from the test hip suggests no muscle extensibility deficits.

FIGURE 1. DUNCAN-ELY TEST

MODIFIED THOMAS TEST

Rationale: Passive test (rectus femoris, iliopsoas, tensor fascia latae (TFL)/iliotibial band)

Client Position: Lying supine at the end of the table with legs together and both knees bent over the edge of the table.

Personal Trainer Position: Standing next to the test leg.

Procedure: The client actively flexes the non-test knee to the chest and holds the hip with their hands in the maximally flexed position. The lumbar spine and pelvis are flat on the table. The test leg is relaxed. The personal trainer conducts three measurements of the test leg: 1) hip angle for iliopsoas length, 2) knee angle for rectus femoris length, and 3) hip abduction angle for tensor fascia lata/iliotibial length. The procedure is then repeated on the opposite side.

Interpretation: No muscle extensibility deficit is considered when the hip and posterior thigh are flat on the table, hip is in line with pelvis (not abducted), and knee remains at a minimum of 90°. Decreased muscle extensibility is considered when the hip is not flat on the table, the hip is abducted, or the knee angle is less than 80 – 90° (Figures 2A – D).

FIGURE 2A. MODIFIED THOMAS TEST—NO MUSCLE EXTENSIBILITY DEFICITS

FIGURE 2B. MODIFIED THOMAS TEST—DECREASED RECTUS FEMORIS

FIGURE 2C. MODIFIED THOMAS TEST—DECREASED ILIOPSOAS

FIGURE 2D. MODIFIED THOMAS TEST—DECREASED TFL

HAMSTRINGS

This section presents two muscle extensibility tests for the hamstrings that are both passive and active tests. The knee extension test can be passively performed by the personal trainer or actively by the client (10). The straight-leg raise tests can also be passively performed by the personal trainer or actively by the client (10,11). The personal trainer must ensure that the client maintains a stable pelvis for all tests since an anterior or posterior positioned pelvis can affect test results (14).

KNEE EXTENSION TEST

Rationale: Passive or active test

Client Position: Lying supine on table with legs together and knees extended.

Personal Trainer Position: Standing next to the test leg.

Passive Procedure: The personal trainer can hold the test leg in the 90-degree hip flexion and 90-degree knee flexion position and then passively extends the knee to a maximum pain free limit. The contralateral hip and knee are kept flat on the table (Figure 3).

Active Procedure: The client holds the test leg in the 90-degree hip flexion and 90-degree knee flexion position and then actively extends the knee until a maximum pain free limit is achieved (Figure 5).

Modification: The contralateral hip and knee can be bent if the client experiences lumbopelvic discomfort. This is illustrated in Figures 4 and 5.

Interpretation: Knee flexion angle greater than 20° indicates decreased hamstring extensibility. Anything less suggests no muscle extensibility deficits.

FIGURE 3. PASSIVE KNEE EXTENSION TEST

FIGURE 4. PASSIVE KNEE EXTENSION TEST—KNEE BENT

FIGURE 5. ACTIVE KNEE EXTENSION TEST—KNEE BENT

STRAIGHT-LEG RAISE TEST

Rationale: Passive or active test

Client Position: Lying supine on table with legs together and knees extended.

Personal Trainer Position: Standing next to the test leg.

Passive Procedure: The personal trainer grasps the test leg, passively flexes the hip, and extends the knee. The knee is fully extended throughout the test. The leg is raised up to a maximum pain-free limit (Figure 6). The contralateral hip and knee are kept flat on the table.

Active Procedure: The client actively flexes the hip and extended knee to a maximum pain free limit (Figure 7).

Modification: The contralateral hip and knee can be bent if the client experiences lumbopelvic discomfort. This is illustrated in Figure 7.

Interpretation: Straight-leg raise of less than 80° from the starting position (leg flat on surface) indicates decreased hamstring extensibility. Anything greater suggests no muscle extensibility deficits.

FIGURE 6. PASSIVE STRAIGHT-LEG RAISE TEST

FIGURE 7. ACTIVE STRAIGHT-LEG RAISE TEST

TENSOR FASCIA LATA (TFL)/ILIOTIBIAL BAND AND HIP ADDUCTORS

This section presents two tests for the TFL/iliotibial band complex and adductors. The Ober test is a passive test for the TFL/iliotibial band complex and is performed by the personal trainer (12,20,24). The adductor length test also has two versions and is another passive test that is performed by the personal trainer (9). The personal trainer must ensure that the client maintains a stable pelvis for all tests.

OBER TEST

Rationale: Passive test

Client Position: Side-lying with top leg straight. Non-test leg is down with hip and knee flexed by client.

Personal Trainer Position: Standing behind the client.

Procedure: The personal trainer grasps the test leg and passively abducts and extends the hip, and then bends the knee to 90 degrees of flexion. The leg is held above hip level and the thigh in line with trunk (Figure 8). The test leg is passively lowered down while the opposite arm stabilizes the pelvis by putting a hand over the iliac crest just above the hip joint.

Interpretation: If the leg remains above the level of the test hip or horizontal level to the table (abducted), the test is considered positive for decreased muscle extensibility (Figure 9). If the hip drops 10 degrees or more below level of the hip or horizontal level (adduction), it suggests no muscle extensibility deficits (Figure 10).

FIGURE 8. OBER TEST—STARTING POSITION

FIGURE 9. OBER TEST—LEG ABOVE HORIZONTAL INDICATES TIGHTNESS (RED LINE)

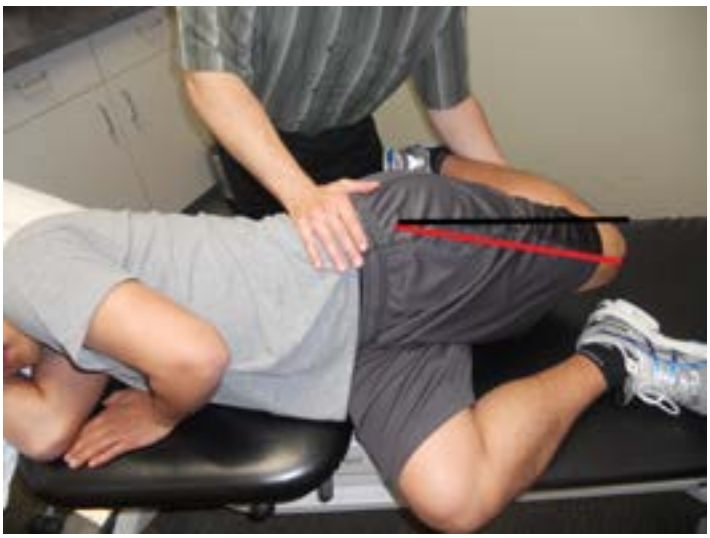

FIGURE 10. OBER TEST—LEG BELOW HORIZONTAL SUGGESTS NO DEFICITS (RED LINE)

HIP ADDUCTOR LENGTH TESTS

Rationale: Passive test

Client Position: Lying supine on the table with legs together and both knees extended.

Personal Trainer Position: Standing on the side of the test leg.

Procedure (knee straight): The personal trainer passively abducts the test hip with the knee extended to a maximum pain-free limit (Figure 11).

Procedure (knee bent): The test hip is passively abducted with the knee flexed to 90 degrees to a maximum pain-free limit (Figure 12).

Interpretation: Knee straight and bent: 45 degrees of abduction or greater suggests no muscle extensibility deficits. If the motion is less, then it is considered decreased extensibility.

**Note: A standard (Figure 11) or digital (Figure 12) goniometric device can be used to measure the degrees of motion.*

FIGURE 11. HIP ADDUCTOR LENGTH TEST—KNEE STRAIGHT

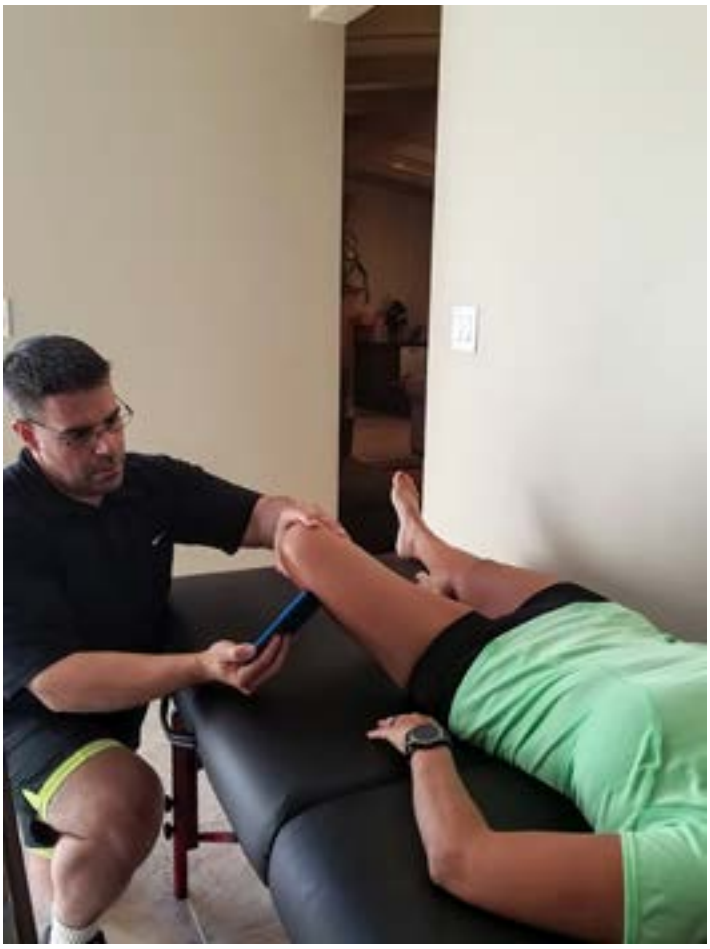

FIGURE 12. HIP ADDUCTOR LENGTH TEST—KNEE BENT AT 90 DEGREES

ANKLE PLANTAR FLEXOR GROUP

This section presents two muscle length test versions for the plantar flexor group (e.g., gastrocnemius, soleus). The non-weight bearing ankle dorsiflexion test is a passive test performed by the personal trainer, and the weight-bearing ankle dorsiflexion test (weight-bearing lunge test) is an active test performed by the client (1,13,23). For both test versions, the knee should remain extended since a knee flexion angle of 10 – 20 degrees eliminates the restraining effects of the gastrocnemius (2,3).

ANKLE DORSIFLEXION TEST

Rationale: Passive and active test

Client Position: Non-weight bearing: Lying supine on the table with legs together and both knees extended. Weight-bearing: standing in a lunge position in front of a wall (shoes off) with the front and back foot flat on floor and feet approximately 4 – 6 in. apart in width.

Personal Trainer Position: Standing on the side of the test leg.

Procedure: Non-weight bearing: The personal trainer passively dorsiflexes the test ankle to a maximum pain-free limit. Weight-bearing: The client assumes the lunge position facing a wall with the test leg in the back and non-test leg in front. The test leg knee is fully extended with the heel on the ground and the foot facing forward. The client lunges towards the wall until a maximum pain-free limit of ankle dorsiflexion is reached in the test leg while keeping the foot flat on the ground.

Interpretation: Non-weight bearing: An ankle dorsiflexion range between 0 – 16 degrees suggests no muscle extensibility deficits. Weight-bearing: An ankle dorsiflexion range between 7 – 35 degrees suggests no muscle extensibility deficits. If the motion is less, then it is considered decreased extensibility.

Non-Weight Bearing Note: In a seated position (Figure 13), zero degrees is considered when the ankle makes a right angle (90 degrees). If the ankle/foot moves up toward the head it is considered dorsiflexion, if the ankle and foot point downward it is considered plantar flexion.

Weight-Bearing Note: In a standing position (Figure 14), zero degrees is considered when the ankle makes a right angle (90 degrees). If the tibia (shin) moves forward over the foot/ankle/toes it is considered dorsiflexion, if the tibia (shin) moves backward it is considered plantar flexion.

**Note: A standard (Figure 13) or digital (Figure 14) goniometric device can be used to measure the degrees of motion.*

FIGURE 13. ANKLE DORSIFLEXION TEST—NON-WEIGHT BEARING

FIGURE 14. ANKLE DORSIFLEXION TEST—WEIGHT-BEARING

DISCUSSION

This article detailed specific lower extremity muscle extensibility tests that are commonly used among allied health professionals and qualified personal trainers. The personal trainer may want to include such tests within the client assessment. These tests are often conducted to confirm the presence of decreased extensibility and to provide rationale for prescribing a flexibility and mobility program for the client. For example, a client may have trouble performing a bodyweight squat through the full range of motion. The personal trainer observes some compensations through the lumbopelvis and lower extremity during the down phase of the movement. The personal trainer suspects that the compensations could be from decreased lower extremity muscle extensibility or a motor control issue. To further assess, the personal trainer may first perform specific lower extremity muscle extensibility tests to rule in or out any deficits, then perform specific motor control tests. This information may help the personal trainer to focus the exercise prescription on the primary issues which may improve the outcomes of the client's program. This brief example illustrates how such muscle extensibility tests can be included in a comprehensive client assessment process. Personal trainers should consider integrating muscle extensibility tests into their client assessments.

PRACTICAL APPLICATION

In the presence of muscle extensibility deficits, the personal trainer may choose to address these issues through a corrective flexibility/mobility program. Personal trainers should consider using the extensibility tests as repeated measures to document and track clients' progress with their programs. For example, the personal trainer can re-test a client every four weeks with specific extensibility tests and track their progress. This may enhance client participation and reinforce the program goals since both the client and personal trainer can observe the changes over time.

The corrective exercise prescription for clients with lower extremity muscle extensibility deficits may involve specific flexibility and mobility exercises such as stretching (e.g., static), dynamic movements, and myofascial rolling (e.g., foam rolling) (25). These interventions can be done in isolation or as a multimodal program depending on the client's needs and health status. The research suggests that a multimodal program consisting of static stretching, dynamic movements, and myofascial rolling may produce favorable outcomes versus a single intervention (5,25). The exercise prescription including parameters such as: intervention type, dosage, and frequency will be specific to each individual client. A comprehensive discussion on this topic is beyond the scope of this article. Readers are encouraged to further research the therapeutic effects of a multimodal flexibility/mobility program versus a single intervention. The reference list provides several manuscripts on the topic.

CONCLUSION

Lower extremity muscle extensibility tests are commonly used by allied health professionals and personal trainers. These tests are easy to administer with little to no equipment. Personal trainers should consider using a goniometric device to document and track a client's progress. These tests should be part of a comprehensive client assessment to determine the influence of muscle extensibility deficits on the client's joint range of motion, mobility, muscle strength, and movement efficiency.

REFERENCES

1. Baggett, BD and Young, G. Ankle joint dorsiflexion. Establishment of a normal range. *Journal American Podiatric Medical Association* 83: 251-254, 1993.

2. Baumbach, SF, Braunstein, M, Seeliger, F, Borgmann, L, Bocker, W, and Polzer, H. Ankle dorsiflexion: what is normal? Development of a decision pathway for diagnosing impaired ankle dorsiflexion and M. gastrocnemius tightness. *Archives of Orthopaedic and Trauma Surgery* 136: 1203-1211, 2016.

3. Baumbach, SF, Brumann, M, Binder, J, Mutschler, W, Regauer, M, and Polzer, H. The influence of knee position on ankle dorsiflexion - a biometric study. *BMC Musculoskeletal Disorders* 15: 246, 2014.

4. Baxter, C, Mc Naughton, LR, Sparks, A, Norton, L, and Bentley, D. Impact of stretching on the performance and injury risk of long-distance runners. *Research in Sports Medicine* 25: 78-90, 2017.

5. Behara, B and Jacobson, BH. Acute effects of deep tissue foam rolling and dynamic stretching on muscular strength, power, and flexibility in Division I linemen. *Journal of Strength and Conditioning Research* 31: 888-892, 2017.

6. Behm, DG, Blazevich, AJ, Kay, AD, and McHugh, M. Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a systematic review. *Applied Physiology, Nutrition, and Metabolism* 41: 1-11, 2016.

7. Bonser, RJ, Hancock, CL, Hansberger, BL, Loutsch, RA, Stanford, EK, Zeigel, AK, Baker, RT, May, J, Nasypany, A, and Cheatham, S. Changes in hamstring range of motion after neurodynamic sciatic sliders: A critically appraised topic. *Journal of Sport Rehabilitation* 26: 311-315, 2017.

8. Bradley, PS, and Portas, MD. The relationship between preseason range of motion and muscle strain injury in elite soccer players. *Journal of Strength and Conditioning Research* 21: 1155-1159, 2007.

9. Cejudo, A, Ayala, F, De Baranda, PS, and Santonja, F. Reliability of two methods of clinical examination of the flexibility of the hip adductor muscles. *International Journal of Sports Physical Therapy* 10: 976-983, 2015.

10. Cejudo, A, Sainz de Baranda, P, Ayala, F, and Santonja, F. Test-retest reliability of seven common clinical tests for assessing lower extremity muscle flexibility in futsal and handball players. *Physical Therapy and Sport* 16: 107-113, 2015.

11. Fasen, JM, O'Connor, AM, Schwartz, SL, Watson, JO, Plastaras, CT, Garvan, CW, Bulcao, C, Johnson, SC, and Akuthota, V. A randomized controlled trial of hamstring stretching: Comparison of four techniques. *Journal of Strength Conditioning Research* 23: 660-667, 2009.

12. Gajdosik, RL, Sandler, MM, and Marr, HL. Influence of knee positions and gender on the Ober test for length of the iliotibial band. *Clinical Biomechanics* 18: 77-79, 2003.

13. Hall, EA and Docherty, CL. Validity of clinical outcome measures to evaluate ankle range of motion during the weight-bearing lunge test. *Journal Science Medicine and Sport* 20: 618-621, 2017.

14. Herrington, L. The effect of pelvic position on popliteal angle achieved during 90:90 hamstring-length test. *Journal of Sport Rehabilitation* 22: 254-256, 2013.

15. Kaufman, KR, Brodine, SK, Shaffer, RA, Johnson, CW, and Cullison, TR. The effect of foot structure and range of motion on musculoskeletal overuse injuries. *The American Journal of Sports Medicine* 27: 585-593, 1999.

16. Lee, SY, Sung, KH, Chung, CY, Lee, KM, Kwon, SS, Kim, TG, Lee, SH, Lee, IH, and Park, MS. Reliability and validity of the Duncan-Ely test for assessing rectus femoris spasticity in patients with cerebral palsy. *Developmental Medicine and Child Neurology* 57(10): 963-968, 2015.

17. Liu, H, Garrett, WE, Moorman, CT, and Yu, B. Injury rate, mechanism, and risk factors of hamstring strain injuries in sports: A review of the literature. *Journal of Sport and Health Science* 1: 92-101, 2012.

18. Mahieu, NN, Witvrouw, E, Stevens, V, Van Tiggelen, D, and Roget, P. Intrinsic risk factors for the development of Achilles tendon overuse injury: A prospective study. *The American Journal of Sports Medicine* 34: 226-235, 2006.

19. Page, P. Current concepts in muscle stretching for exercise and rehabilitation. *International Journal of Sports Physical Therapy* 7: 109-119, 2012.

20. Park, JH, Kang, SY, Choung, SD, Jeon, HS, and Kwon, OY. Effects of tibial rotation on Ober's test and patellar tracking. *The Knee* 23: 600-603, 2016.

21. Peeler, J, and Anderson, JE. Reliability of the Ely's test for assessing rectus femoris muscle flexibility and joint range of motion. *Journal of Orthopedic Research* 26: 793-799, 2008.

22. Peeler, JD, and Anderson, JE. Reliability limits of the modified Thomas test for assessing rectus femoris muscle flexibility about the knee joint. *Journal of Athletic Training* 43: 470-476, 2008.

23. Powden, CJ, Hoch, JM, and Hoch, MC. Reliability and minimal detectable change of the weight-bearing lunge test: A systematic review. *Manual Therapy* 20: 524-532, 2015.

24. Reese, NB, and Bandy, WD. Use of an inclinometer to measure flexibility of the iliotibial band using the Ober test and the modified Ober test: differences in magnitude and reliability of measurements. *Journal of Orthopedic and Sports Physical Therapy* 33: 326-330, 2003.

25. Su, H, Chang, NJ, Wu, WL, Guo, LY, and Chu, IH. Acute effects of foam rolling, static stretching, and dynamic stretching during warm-ups on muscular flexibility and strength in young adults. *Journal of Sport Rehabilitation* 26: 469-477, 2017.

26. Weppler, CH and Magnusson, SP. Increasing muscle extensibility: A matter of increasing length or modifying sensation? *Physical Therapy* 90: 438-449, 2010.

27. Witvrouw, E, Danneels, L, Asselman, P, D'Have, T, and Cambier, D. Muscle flexibility as a risk factor for developing muscle injuries in male professional soccer players. A prospective study. *The American Journal of Sports Medicine* 31: 41-46, 2003.

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