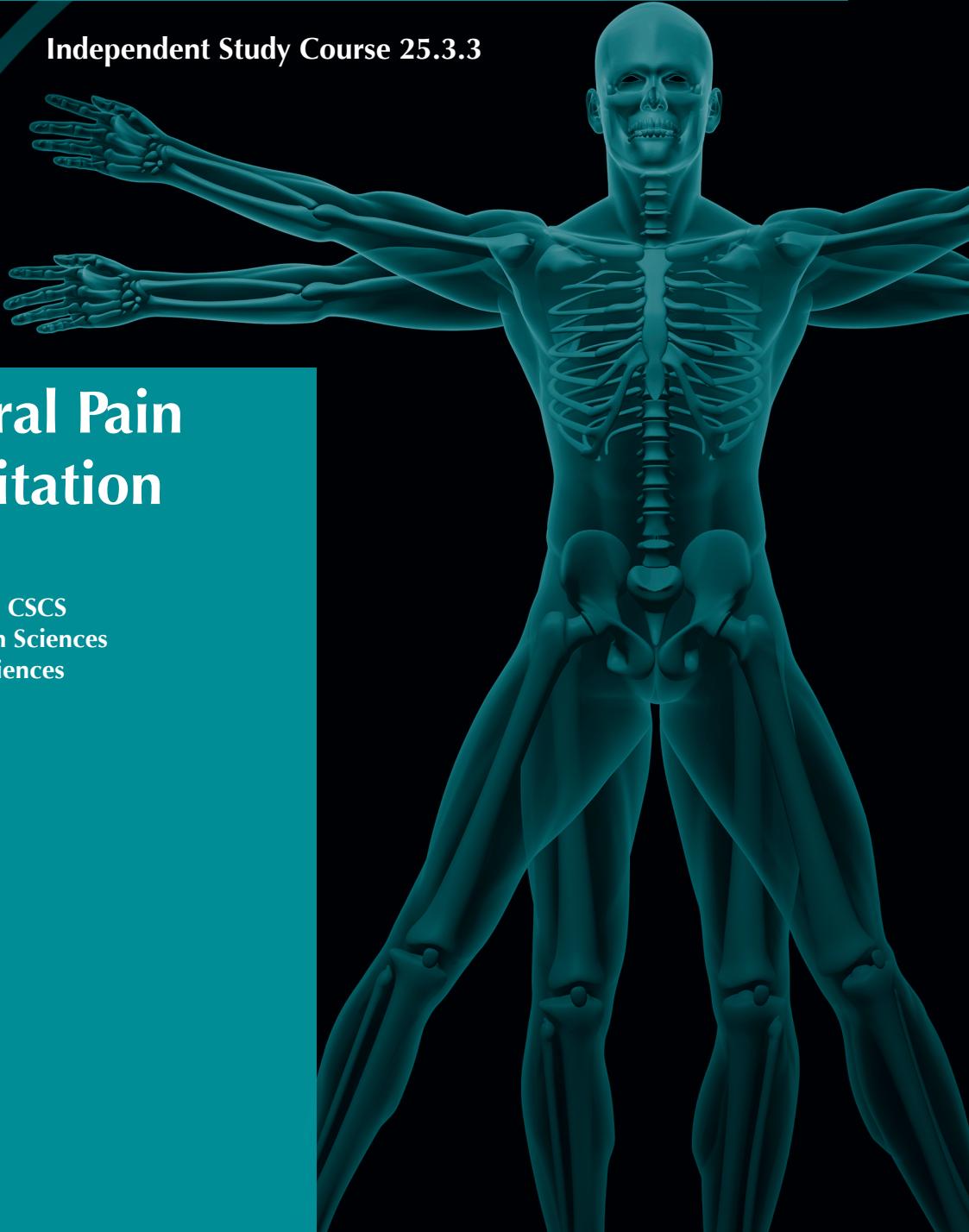


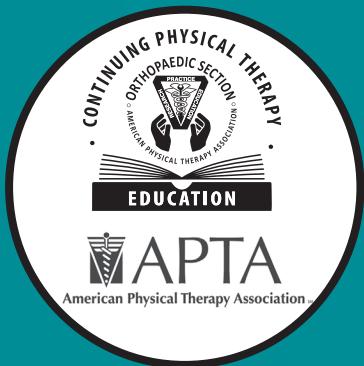
Alternative Special Topics: Innovations in Practice

Independent Study Course 25.3.3



Patellofemoral Pain and Rehabilitation

Cory Manton, PT, DPT, OCS, CSCS
A.T. Still University of Health Sciences
Arizona School of Health Sciences
Physical Therapy Program
Mesa, Arizona



REFERENCES

1. Miller L. Health: one bum knee meets five physical therapists. *Wall Street Journal*. Eastern ed. September 22, 1994:B1.
2. Wood L, Muller S, Peat G. The epidemiology of patellofemoral disorders in adulthood: a review of routine general practice morbidity recording. *Prim Health Care Res Dev*. 2011;12:157-164. doi: 10.1017/S1463423610000460.
3. McConnell J. The management of chondromalacia patellae: a long term solution. *Aust J Physiother* er. 1986;32(4):215-223. doi: 10.1016/S0004-9514(14)60654-1.
4. Witvrouw E, Werner S, Mikkelsen C, Van Tiggelen DV, Vanden Berghe L, Cerulli G. Clinical classification of patellofemoral pain syndrome: guidelines for non-operative treatment. *Knee Surg Sports Traumatol Arthrosc*. 2005;13:122-130.
5. World Health Organization. How to use the ICF: a practical manual for using the International Classification of Functioning, Disability and Health

- (ICF). Exposure draft for comment. October 2013. Geneva: WHO.
6. American Physical Therapy Association. Guide to Physical Therapist Practice 3.0. Guide to physical therapist practice. guidetoptpractice.apta.org. Accessed September 8, 2014.
 7. Levangie PK, Norkin CC. *Joint Structure and Function: A Comprehensive Analysis*. 5th ed. Philadelphia, PA: FA Davis Company; 2011:395-439.
 8. Fulkerson JP. *Disorders of the Patellofemoral Joint*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2004.
 9. Neumann DA. *Kinesiology of the Musculoskeletal System: Foundations for Rehabilitation*. 2nd ed. St. Louis, MO: Mosby Elsevier; 2010:520-572.
 10. Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. *Knee Surg Sports Traumatol Arthroscopy*. 1994;2:19-26.
 11. Grelsamer RP, Weinstein CH. Applied biomechanics of the patella. *Clin Orthop Relat Res*. 2001;389:9-14.
 12. Wiberg G. Roentgenographic and anatomic studies on the femoropatellar joint: with special reference to chondromalacia patellae. *Acta Orthop*. 1941;319-410.
 13. Goodfellow J, Hungerford DS, Zindel M. Patello-femoral joint mechanics and pathology:1. Functional anatomy of the patella-femoral joint. *J Bone Joint Surg Br*. 1976;58-B(3):287-290.
 14. Heegaard J, Leyvraz PF, Curneir A, Rakotomanana L, Huiskes R. The biomechanics of the human patella during passive knee flexion. *J Biomech*. 1995;28(11):1265-1279.
 15. Techlenburg K, Dejour D, Hoser C, Fink C, Bony and cartilaginous anatomy of the patellofemoral joint. *Knee Surg Sports Traumatol Arthrosc*. 2006;14:235-240.
 16. Bull AMJ, Katchburian MV, Shih YF, Amis AA. Standardisation of the description of patellofemoral motion and comparison between different techniques. *Knee Surg Sports Traumatol Arthrosc*. 2002;10:184-193.
 17. Hungerford DS, Barry M. Biomechanics of the patellofemoral joint. *Clin Orthop Relat Res*. 1979;144:9-15.
 18. Zaffagnini S, Colle F, Lopomo N, et al. The influence of medial patellofemoral ligament on patellofemoral joint kinematics and patellar stability. *Knee Surg Sports Traumatol Arthrosc*. 2013;21:2164-2171. doi: 10.1007/s00167-012-2307-9.
 19. Powers CM, Ward SR, Fredericson M, Guillet M, Shellock FG. Patellofemoral kinematics during weight-bearing and non-weight bearing knee extension in persons with lateral subluxation of the patella: a preliminary study. *J Orthop Sports Phys Ther*. 2003;33(11):677-685.
 20. Amis AA. Current concepts on anatomy and biomechanics of patellar stability. *Sports Med Arthrosc Rev*. 2007;15:48-56.
 21. Desio SM, Burks RT, Bachus KN. Soft tissue restraints to lateral patellar translation in the human knee. *Am J Sports Med*. 1998;26(1):59-65.
 22. Witvrouw E, Lysens R, Bellemans J, Cambier D, Vanderstraeten G. Intrinsic risk factors for the development of anterior knee pain in an athletic population: a two year prospective study. *Am J Sports Med*. 2000;28(4):480-489.
 23. Powers CM, Lilley JC, Lee TQ. The effects of axial and multi-plane loading of the extensor mechanism on the patellofemoral joint. *Clin Biomech (Bristol, Avon)*. 1998;13:616-624.
 24. Davis IS, Powers CM. Patellofemoral pain syndrome: proximal, distal, and local factors; an international research retreat. *J Orthop Sports Phys Ther*. 2010;40(3):A1-A48.
 25. Powers C. Mechanisms of patellofemoral pain and ACL injury: implications for rehabilitation and injury prevention. Continuing education course: presented at A.T. Still University; January 13 & 14, 2012; Mesa, AZ.
 26. Wainner RS, Whitman JM, Cleland JA, Flynn TW. Regional interdependence: a musculoskeletal examination model whose time has come. *J Orthop Sports Phys Ther*. 2007;37(11): 658-660.
 27. Brechter JH, Powers CM. Patellofemoral stress during walking in persons with and without patellofemoral pain. *Med Sci Sports Exerc*. 2002;34(10):1582-1593.
 28. Mueller MJ, Maluf KS. Tissue adaption to physical stress: a proposed "physical stress theory" to guide physical therapist practice, education, and research. *Phys Ther*. 2002;82:383-403.
 29. McConnell J. Management of patellofemoral problems. *Man Ther*. 1996;1:60-66.
 30. Powers CM. The influence of altered lower-extremity kinematics on patellofemoral joint dysfunction: a theoretical perspective. *J Orthop Sports Phys Ther*. 2003;33(11):639-646.
 31. Insall J, Salvati E. Patella position in the normal knee joint. *Radiology*. 1971;101:101-104.
 32. Phillips CL, Silver DA, Schranz PJ, Mandalia V. The measurement of patellar height: a review of the methods of imaging. *J Bone Joint Surg (Br)*. 2010;92-B:1045-1053. doi: 10.1302/0301-620X.92B8.23794.

33. Stefanik JJ, Neogi T, Niu J, et al. The diagnostic performance of anterior knee pain and activity-related pain in identifying knees with structural damage in the patellofemoral joint: the multicenter osteoarthritis study. *J Rheumatol.* 2014;41(7):1-8. doi: 10.3899/jrheum.131555.
34. Merchant AC, Mercer RL, Jacobsen RH, Cool CR. Roentgenographic analysis of patellofemoral congruence. *J Bone Joint Surg Am.* 1974;56(7):1391-1396.
35. McKinnis LN. *Fundamentals of Musculoskeletal Imaging*. 3rd ed. Philadelphia, PA: FA Davis Company; 2010:384-385.
36. Jungmann PM, Tham SC, Liebl H, et al. Association of trochlear dysplasia with degenerative abnormalities in the knee: data from the Osteoarthritis Initiative. *Skeletal Radiol.* 2013;42(10):1383-1392. doi: 10.1007/s00256-013-1664-x.
37. Lankhorst NE, Bierma-Zeinstra SMA, van Middelkoop M. Factors associated with patellofemoral pain syndrome: a systematic review. *Br J Sports Med.* 2013;47:193-206. doi: 10.1136/bjsports-2011-090369.
38. Schulthies SS, Francis RS, Fisher AG, Van De Graaff KM. Does the Q angle reflect the force on the patella in the frontal plane? *Phys Ther.* 1995;75:24-30.
39. Livingston LA. The quadriceps angle: a review of the literature. *J Orthop Sports Phys Ther.* 1998;28(2):105-109.
40. Rauh MJ, Koepsell TD, Rivara FP, Rice SG, Margheria AJ. Quadriceps angle and risk of injury among high school cross-country runners. *J Orthop Sports Phys Ther.* 2007;37(12):725-733. doi: 10.2519/jospt.2007.2453.
41. Lankhorst NE, Bierma-Zeinstra SMA, Van Middelkoop M. Risk factors for patellofemoral pain syndrome: a systematic review. *J Orthop Sports Phys Ther.* 2012;42(2):81-94. doi: 10.2519/jospt.2012.3803.
42. Cook CE, Hegedus EJ. *Orthopedic Physical Examination Tests: An Evidence-based Approach*. 2nd ed. Upper Saddle River, NJ: Pearson Education, Inc; 2013.
43. Chester R, Smith TO, Sweeting D, Dixon J, Wood S, Song F. The relative timing of VMO and VL in the aetiology of anterior knee pain: a systematic review and meta-analysis. *BMC Musculoskeletal Disord.* 2008;9:64. doi: 10.1186/1471-2474-9-64.
44. Giles LS, Webster KE, McClelland JA, Cook J. Can ultrasound measurements of muscle thickness be used to measure the size of individual quadriceps muscles in people with patellofemoral pain? *Phys Ther Sport.* 2015;16(1):45-52. doi: 10.1016/j.ptsp.2014.04.002.
45. Powers CM. The influence of abnormal hip mechanics on knee injury: a biomechanical perspective. *J Orthop Sports Phys Ther.* 2010;40(2):42-51. doi: 10.2519/jospt.2010.3337.
46. Fritz JM, Piva SR, Childs JD. Accuracy of the clinical examination to predict radiographic instability of the lumbar spine. *Eur Spine J.* 2005;14:743-750.
47. Bruno PA, Goertzen DA, Millar DP. Patient-reported perception of difficulty as a clinical indicator of dysfunctional neuromuscular control during the prone hip extension test and active straight leg raise test. *Man Ther.* 2014;19(6):602-607. doi: 10.1016/j.math.2014.06.002.
48. Ambegaonkar JP, Mettinger LM, Caswell SV, Burtt A, Cortes N. Relationships between core endurance, hip strength, and balance in collegiate female athletes. *Int J Sports Phys Ther.* 2014;9(5):604-616.
49. Sahrmann SA. *Diagnosis and Treatment of Movement Impairment Syndromes*. St. Louis, MO: Mosby; 2002.
50. Souza RB, Draper CE, Fredericson M, Powers CM. Femur rotation and patellofemoral joint kinematics: a weight-bearing magnetic resonance imaging analysis. *J Orthop Sports Phys Ther.* 2010;40(5):277-285. doi: 10.2519/jospt.2010.3215.
51. Jones PA, Herrington LC, Munro AG, Graham-Smith P. Is there a relationship between landing, cutting, and pivoting tasks in terms of characteristics of dynamic valgus? *Am J Sports Med.* 2014;42:2095-2102. doi: 10.1177/0363546514539446.
52. Witvrouw E, Callaghan MJ, Stefanik JJ, et al. Patellofemoral pain: consensus statement from the 3rd international Patellofemoral Pain Research Retreat held in Vancouver, September 2013. *Br J Sports Med.* 2014;48:411-414. doi: 10.1136/bjsports-2014-093450.
53. Rathleff MS, Rathleff CR, Crossley KM, Barton CJ. Is hip strength a risk factor for patellofemoral pain? A systematic review and meta-analysis. *Br J Sports Med.* 2013;0:1-12. doi: 10.1136/bjsports-2013-093305.
54. Souza RB, Powers CM. Concurrent criterion-related validity and reliability of a clinical test to measure femoral anteverision. *J Orthop Sports Phys Ther.* 2009;39(8):586-592. doi: 10.2519/jospt.2009.2996.

55. Rabin A, Kozol Z, Spitzer E, Finestone A. Ankle dorsiflexion among healthy men with different qualities of lower extremity movement. *J Athl Train*. 2014;49(5):617-623. doi: 10.4085/1062-6050-49.3.14.
56. Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. *Muscles: Testing and Function with Posture and Pain*. 5th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2005.
57. Beighton P, Horan F. Orthopaedic aspects of the Ehlers-Danlos syndrome. *J Bone Joint Surg Br*. 1969;51(3):444-453.
58. Boyle KL, Witt P, Rieger-Krugh C. Intrarater and interrater reliability of the Beighton and Horan joint mobility index. *J Athl Train*. 2003;38(4):281-285.
59. Junge T, Jespersen E, Wedderkopp, Juul-Kristensen B. Inter-tester reproducibility and inter-method agreement of two variations of the Beighton test for determining generalized joint hypermobility in primary school children. *BMC Pediatr*. 2013;13:214. doi: 10.1186/1471-2431-13-214.
60. Rathlef MS, Skuldbol SK, Rasch MD, Roos EM, Rasmussen S, Oleden JL. Care-seeking behaviour of adolescents with knee pain: a population-based study among 504 adolescents. *BMC Musculoskeletal Disorders*. 2013;14:225. doi: 10.1186/1471-2474-14-225.
61. Boling M. Research considerations based on the evidence for the incidence and prevalence of patellofemoral pain syndrome. *Phys Ther Rev*. 2010;15(1):40.
62. Boling M, Padua D, Marshall S, Guskeiwicz K, Pyne S, Beutler A. Gender differences in the incidence and prevalence of patellofemoral pain syndrome. *Scan J Med Sci Sports*. 2010;20:725-730. doi: 10.1111/j.1600-0838.2009.00996.x.
63. Maitland GD. *Peripheral Manipulation*. 3rd ed. Oxford: Butterworth-Heinemann; 1991.
64. Dutton M. *Dutton's Orthopaedic Examination, Evaluation, and Intervention*. 3rd ed. New York, NY: McGraw-Hill Medical; 2012.
65. Venes D, ed. *Taber's Cyclopedic Medical Dictionary*. 22nd ed. Philadelphia, PA: FA Davis Company; 2013.
66. Ludewig PM, Lawrence RL, Braman JP. What's in a name? Using movement system diagnoses versus pathoanatomic diagnoses. *J Orthop Sports Phys Ther*. 2013;43(5):280-283. doi: 10.2519/jospt.2013.0104.
67. Fritz JM, Cleland JA, Childs JD. Subgrouping patients with low back pain: evolution of a classification approach to physical therapy. *J Orthop Sports Phys Ther*. 2007;37(6):290-302.
68. Van Dillen LR, Sahrmann SA, Norton BJ, Caldwell CA, McDonnell MK, Bloom NJ. Movement system impairment-based categories for low back pain: stage 1 validation. *J Orthop Sports Phys Ther*. 2003;33(3):126-142.
69. Delitto A, George SZ, Van Dillen, L, et al. Low back pain: clinical practice guidelines linked to the international classification of functioning, disability, and health from the orthopaedic section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2012;42(4):A1-A57.
70. DuVall RE, Godges J. Medical Screening for the physical therapist. Independent study course 14.1.1.La Crosse, WI: Orthopaedic Section, American Physical Therapy Association; 2004.
71. Cook C, Marby L, Reiman MP, Hegedus EJ. Best tests/clinical findings for screening and diagnosis of patellofemoral pain syndrome: a systematic review. *Physiotherapy*. 2012;98:93-100. doi: 10.1016/j.physio.2011.09.001.
72. Stiell IG, Greenberg GH, Wells GA, et al. Derivation of a decision rule for the use of radiography in acute knee injuries. *Ann Emerg Med*. 1995;26(4):405-413.
73. Stiell IG, Greenberg GH, Wells GA, et al. Prospective validations of a decision rule for the use of radiography in acute knee injuries. *JAMA*. 1996;275(8):611-615.
74. Richman PB, McCuskey CF, Nashed A, et al. Performance of two clinical decision rules for knee radiography. *J Emerg Med*. 1997;15(4):459-463.
75. Bachmann LM, Haberzeth S, Steurer J, Riet G. The accuracy of the Ottawa knee rule to rule out knee fractures: a systematic review. *Ann Intern Med*. 2004;140(2):121-124.
76. Pellecchia GL, Paolino J, Connell J. Intertester reliability of the Cyriax evaluation in assessing patients with shoulder pain. *J Orthop Sports Phys Ther*. 1996;23(1):34-38.
77. Kelley MJ, Shaffer MA, Kuhn JE, et al. Shoulder pain and mobility deficits: adhesive capsulitis. Clinical practice guidelines linked to international classification of functioning, disability, and health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2013;43(5):A1-A31.
78. Christensen N, Jones MA, Edwards I. Clinical reasoning and evidence-based practice. Independent Study Course 21.2.1. La Crosse, WI: Orthopaedic Section; 2011.
79. Goodman CC, Snyder TEK. *Differential Diagnosis for Physical Therapists: Screening for Referral*. 4th ed. St. Louis, MO: Saunders Elsevier; 2007.

80. Michener LA. Patient- and clinician- rated outcome measures for clinical decision making in rehabilitation. *J Sport Rehabil.* 2011;20:37-45.
81. Haxby Abbott J, Schmitt J. Minimum important differences for the patient-specific functional scale, 4 region-specific outcome measures, and the numeric pain rating scale. *J Orthop Sports Phys Ther.* 2014;44(8):560-564. doi: 10.2519/jospt.2014.5248.
82. Esculier JF, Roy JS, Bouyer LJ. Psychometric evidence of self reported questionnaires for patellofemoral pain syndrome: a systematic review. *Disabil Rehabil.* 2013;35(26):2181-2190. doi: 10.3109/09638288.2013.774061.
83. Binkley JM, Stratford PW, Lott SA, Riddle DL, The North American Orthopaedic Rehabilitation Research Network. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. *Phys Ther.* 1999;79:371-383.
84. Watson CJ, Propp M, Ratner J, Zeigler DL, Horton P, Smith SS. Reliability and responsiveness of the lower extremity functional scale and the anterior knee pain scale in patients with anterior knee pain. *J Orthop Sports Phys Ther.* 2005;35:136-146.
85. Stratford P, Gill C, Westaway M, Binkley J. Assessing disability and change on individual patients: a report of a patient specific measure. *Physiother Can.* 1995;47:258-263.
86. Chatman AB, Hyams SP, Neel JM, et al. The patient-specific functional scale: measurement properties in patients with knee dysfunction. *Phys Ther.* 1997;77:820-829.
87. Waddell G, Newton M, Henderson I, Somerville D, Main C. A fear-avoidance beliefs questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain.* 1993;52:157-168.
88. Piva SR, Fitzgerald GK, Wisniewski S, Delitto A. Predictors of pain and function outcome after rehabilitation in patients with patellofemoral pain syndrome. *J Rehabil Med.* 2009;41:604-612. doi: 10.2340/16501977-0372.
89. Logerstedt DS, Snyder-Mackler L, Ritter RC, Axe MJ. Knee pain and mobility impairments: meniscal and articular cartilage lesions. Clinical practice guidelines linked to international classification of functioning, disability, and health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther.* 2010;40(6):A1-A35. doi: 10.2519/jospt.2010.0304.
90. Rabin A, Kozol Z, Moran U, Efergan A, Geffen Y, Finestone AS. Factors associated with visually assessed quality of movement during a lateral step down test among individuals with patellofemoral pain. *J Orthop Sports Phys Ther.* 2014;44(12):937-946. doi: 10.2519/jospt.2014.5507.
91. Piva SR, Fitzgerald K, Irrgang JJ, et al. Reliability of measures of impairments associated with patellofemoral pain syndrome. *BMC Musculoskeletal Disord.* 2006;7:33.
92. Rabin A, Kozol Z. Measures of range of motion and strength among healthy women with differing quality of lower extremity movement during the lateral step down test. *J Orthop Sports Phys Ther.* 2010;40(12):792-800. doi: 10.2519/jospt.2010.3424.
93. Ubersense Inc. <http://www.ubersense.com>. Accessed on October 30, 2014.
94. CoachMyVideo. <http://www.coachmyvideo.mobi>. Accessed on October 30, 2014.
95. Dartfish. http://www.dartfish.com/en/heathcare/gait_analysis_software/physiotherapy_orthopedics.htm. Accessed on November 12, 2014.
96. Movement Performance Institute. <http://movementpi.com>. Accessed on October 30, 2014.
97. Spaulding National Running Center. <http://spauldingrehab.org/conditions-and-treatments/natl-running-center>. Accessed on October 30, 2014.
98. University of Wisconsin Health Sports Medicine Runners Clinic. <http://www.uwhealth.org/physical-therapy-athletic-training/runners-clinic/11310>. Accessed on October 30, 2014.
99. Washington University School of Medicine in St. Louis. Movement System Impairment Syndrome Courses. <https://pt.wustl.edu/EDUCATION/CONTINUINGEDUCATION/Pages/MovementSystemImpairmentSyndromeCourses.aspx>. Accessed October 30, 2014.
100. Functional Movement Systems. <http://www.functionalmovement>. Accessed October 30, 2014.
101. Gray Institute. <http://www.grayinstitute.com>. Accessed October 30, 2014.
102. Arendt EA, Dejour D. Patella instability: building bridges across the ocean, a historic review. *Knee Surg Sports Traumatol Arthrosc.* 2013;21:279-293. doi: 10.1007/s00167-012-2274-1.
103. Buckens CFM, Saris DBF. Reconstruction of the medial patellofemoral ligament for treatment of patellofemoral instability: a systematic review. *Am J Sports Med.* 2010;38(1):181-188. doi: 10.1177/0363546509353132.
104. Miller MD, Thompson SR. *DeLee & Drez's Orthopaedic Sports Medicine*. 4th ed. Philadelphia, PA: Elsevier; 2015.
105. Fithian DC, Powers CM, Khan N. Rehabilitation of the knee after medial patellofemoral ligament

- reconstruction. *Clin Sports Med.* 2010;29(2):283-290. doi: 10.1016/j.csm.2009.12.008.
106. LeGrand AB, Greis PE, Dobbs RE, Burks RT. MPFL reconstruction. *Sports Med Arthrosc Rev.* 2007;15(2):72-77.
107. Wagner D, Pfalzer F, Hingelbaum S, Huth J, Mauch F, Bauer G. The influence of risk factors on clinical outcomes following anatomical medial patellofemoral ligament (MPFL) reconstruction using the gracilis tendon. *Knee Surg Sports Traumatol Arthrosc.* 2013;21:318-324. doi: 10.1007/s00167-012-2015-5.
108. Hart JM, Pietrosimon B, Hertel J, Ingersoll CD. Quadriceps activation following knee injuries: a systematic review. *J Athl Train.* 2010;45(1):87-97. doi: 10.4085/1062-6050-45.1.87.
109. Palmieri-Smith RM, Villwock M, Downie B, Hecht G, Zernicke R. Pain and effusion and quadriceps activation and strength. *J Athl Train.* 2013;48(2):186-191. doi: 10.4085/1062-6050-48.2.10.
110. Harkey MS, Gribble PA, Piestrosimone BG. Disinhibitory interventions and voluntary activation: a systematic review. *J Athl Train.* 2014;49(3):411-412. doi: 10.4085/1062-6050-49.1.04.
111. Bolgla LA, Boling MC. An update for the conservative management of patellofemoral pain syndrome: a systematic review of the literature from 2000 to 2010. *Int J Sports Phys Ther.* 2011;6(2):112-125.
112. Barton C, Balachandar V, Lack S, Morrissey D. Patellar taping for patellofemoral pain: a systematic review and meta-analysis to evaluate clinical outcomes and biomechanical mechanisms. *Br J Sports Med.* 2014;48:417-424. doi: 10.1136/bjsports-2013-092437.
113. Powers CM, Ho KY, Chen KJ, Souza RB, Farrokhi S. Patellofemoral joint stress during weight-bearing and non-weight-bearing quadriceps exercises. *J Orthop Sports Phys Ther.* 2014;44(5):320-327. doi: 10.2519/jospt.2014.4936.
114. Escamilla R, Fleisig GS, Zheng N, Barrentine SW, Wilk KE, Andrews JR. Biomechanics of the knee during closed chain and open kinetic chain exercises. *Med Sci Sport Exer.* 1998;30(4):556-569.
115. Smith TO, Bowyer D, Dixon J, et al. Can vastus medialis oblique be preferentially activated? A systematic review of electromyographic studies. *Physiother Theory Pract.* 2009;25(2):69-98. doi: 10.1080/09593980802686953.
116. Mirzabeigi E, Jordan C, Gronley JK, Rockowitz NL, Perry J. Isolation of the vastus medialis oblique muscle during exercise. *Am J Sports Med.* 1999;27(1):50-53.
117. Spairani L, Barbero M, Cescon C, et al. An electromyographic study of the vastii muscles during open and closed chain submaximal exercises. *Int J Sports Phys Ther.* 2012;7(6):617-626.
118. Dolak KI, Silkman C, McKeon JM, Hosey RG, Latterman C, Uhl TL. Hip strengthening prior to functional exercises reduces pain sooner than quadriceps strengthening in females with patellofemoral pain syndrome: a randomized clinical trial. *J Orthop Sports Phys Ther.* 2011;41(8):560-570. doi: 10.2519/jospt.2011.3499.
119. Earl JE, Hoch AZ. A proximal strengthening program improves pain, function, and biomechanics with patellofemoral pain syndrome. *Am J Sports Med.* 2011;39(1):154-163. doi: 10.1177/0363546510379967.
120. Khayambashi K, Mohammadkhani Z, Ghaznavi K, Lyle MA, Powers CM. The effects of isolated hip abductor and external rotator muscle strengthening on pain, health status, and hip strength in females with patellofemoral pain: a randomized controlled trial. *J Orthop Sports Phys Ther.* 2012;42(1):22-29. doi: 10.2519/jospt.2012.3704.
121. Peters JS, Tyson NL. Proximal exercises are effective in treating patellofemoral pain syndrome: a systematic review. *Int J Sports Phys Ther.* 2013;8(5):689-700.
122. Baldon RDM, Serrao FV, Silva RS, Piva SR. Effects of functional stabilization training on pain, function, and lower extremity biomechanics in women with patellofemoral pain: a randomized clinical trial. *J Orthop Sports Phys Ther.* 2014;44(4):240-251. doi: 10.2519/jospt.2014.4940.
123. Mascal CL, Landel R, Powers C. Management of patellofemoral pain targeting hip, pelvis, and trunk muscle function: 2 case reports. *J Orthop Sports Phys Ther.* 2003;33:642-660.
124. Reiman MP, Bolgla LA, Loudon JK. A literature review of studies evaluating gluteus maximus and gluteus medius activation during rehabilitation exercises. *Physiother Theory Pract.* 2012;28(4):257-268. doi: 10.3109/09593985.2011.604981.
125. Selkowitz DM, Beneck GJ, Powers CM. Which exercises target the gluteal muscles while minimizing activation of the tensor fascia lata? Electromyographic assessment using fine-wire electrodes. *J Orthop Sports Phys Ther.* 2013;43(2):54-64. doi: 10.2519/jospt.2013.4116.
126. Teng H, Powers CM. Sagittal plane trunk posture influences patellofemoral joint stress during running. *J Orthop Sports Phys Ther.* 2014;44(10):785-792. doi: 10.2519/jospt.2014.5249.

127. Collins N, Crossley K, Beller E, Darnell R, McPoil T, Vicenzino B. Foot orthoses and physiotherapy in the treatment of patellofemoral pain syndrome: randomized clinical trial. *Br J Sports Med.* 2009;43:169-171. doi: 10.1136/bmj.a1735.
128. Eng JJ, Pierrynowski MR. Evaluation of soft foot orthotics in the treatment of patellofemoral pain syndrome. *Phys Ther.* 1993;73(2):62-68.
129. Sutlive TG, Mitchell SD, Maxfield SN, et al. Identification of individuals with patellofemoral pain whose symptoms improved after a combined program of foot orthosis use and modified activity: a preliminary investigation. *Phys Ther.* 2004;84(1):49-61.
130. Vicenzino B, Collins N, Cleland J, McPoil T. A clinical prediction rule for identifying patients with patellofemoral pain who are likely to benefit from foot orthoses: a preliminary determination. *Br J Sports Med.* 2010;44:862-866. doi: 10.1136/bjsm.2008.052613.
131. Mills K, Blanch P, Dev P, Martin M, Vicenzino B. A randomized control trial of short term efficacy of in-shoe foot orthoses compared with a wait and see policy for anterior knee pain and the role of foot mobility. *Br J Sports Med.* 2012;46:247-252. doi: 10.1136/bjsports-2011-090204.
132. Barton CJ, Menz HB, Crossley KM. Clinical predictors of foot orthoses efficacy in individuals with patellofemoral pain. *Med Sci Sports Exerc.* 2011;43(9):1603-1610. doi: 10.1249/MSS.0b013e318211c45d.
133. Barton CJ, Menz HB, Levinger P, Webster KE, Crossley KM. Greater peak rearfoot eversion predicts foot orthoses efficacy in individuals with patellofemoral pain syndrome. *Br J Sports Med.* 2011;45:697-701. doi: 10.1136/bjsm.2010.077644.
134. McPoil TG, Vecenzio B, Cornwall MW, Collins N, Warren M. Reliability and normative values for the foot mobility magnitude: a composite measure of vertical and medial-lateral mobility of the midfoot. *J Foot Ankle Res.* 2009;2:6. doi: 10.1186/1757-1146-2-6.

NOTES