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LOWER EXTREMITY INJURIES: IS IT JUST ABOUT THE HIP STRENGTH?

Bryan Heiderscheit, PT, PhD[Associate Professor]

Department of Orthopedics and Rehabilitation, Department of Biomedical Engineering, University of Wisconsin School of Medicine and Public Health, Madison, WI 53706-1532

Patellofemoral pain and iliotibial band syndromes continue to puzzle and oftentimes frustrate both patients and clinicians alike. While a myriad of treatments including footwear, orthoses, bracing, patellar taping, and quadriceps strengthening have been traditionally promoted, and some shown moderately effective,^{4,31} improvements in symptoms and function are not universal. In recent years, a trend toward consideration of more proximal influences on knee injuries (ie, lumbopelvic and hip regions) has continued to grow as insights are gained into this potential mechanism.

While the attention paid to proximal factors is increasing, the presumed association between hip impairments and knee injuries has been suggested for some time.¹⁸ Quite simply, the anatomy and joint mechanics dictate that an interdependence exists between the hip and knee in weight-bearing postures.¹⁷ Therefore, it follows that an impairment at either joint has the potential to produce a compensation and injury at the other. Indeed, treatment programs incorporating exercises designed to address hip impairments have demonstrated positive short and long term outcomes on knee injuries.^{6,16,30} However, the specific cause-effect relationship is not as clear as we might anticipate.

Hip muscle weakness, specifically of the abductors and external rotators, is believed to contribute to the increased hip adduction and internal rotation that has been observed in females with pain approximating the patellofemoral joint or iliotibial band.^{6,10,15,19,27} However, it is not apparent that muscle weakness is necessary for these abnormal kinematics to occur. For example, in 2 studies, females with a history of iliotibial band syndrome demonstrated approximately 30% greater peak hip adduction motion during running, despite having essentially identical hip abductor torque profiles as females without prior knee injury.^{5,20} Additional studies have also demonstrated a disconnect between muscle strength and observed joint motions indicating this rather intuitive relationship should not be viewed as absolute.^{1,2,8,13,24-26,28}

If muscle weakness were the sole cause of the abnormal joint motion, then it stands to reason that the abnormal joint motion would only be apparent when the demands on the muscle exceed its capabilities. That is, excessive hip adduction and internal rotation would be observed only when the hip abductors' and external rotators' torque producing capacity is surpassed. However, this does not seem to be the case. For example, increased hip adduction appears to be present across the stance phase of running, from initial foot-ground contact through toe-off.^{5,20} Thus, the abnormal joint motion is even apparent when the muscular demands are rather minimal (ie, initial foot-ground contact). Further, abnormal hip mechanics do not appear to worsen as muscle weakness (in the form of fatigue) is introduced.³⁴ Additional factors such as altered proprioception³⁵ and neuromuscular control¹⁴ should be considered as contributing to the abnormal motion and, when warranted, addressed in the treatment plan.

Given the inconsistent relationship between hip muscle weakness and abnormal joint motion, the question remains as to whether successful recovery can be obtained if the treatment is limited to only one aspect. That is, can a treatment strategy focused solely on strengthening achieve successful outcomes? For example, individuals with a history of iliotibial band syndrome (ie, those who no longer experience symptoms or receive care) continue to display altered hip motion during running,^{5,11} suggesting that movement reeducation may not be an essential aspect of care. However, the persistence of abnormal joint motion may compromise long term benefits, as the symptoms may be more prone to recur. Conversely, is movement re-education alone sufficient for recovery? For example, improved joint mechanics during landing were achieved regardless of the individual's muscle strength, suggesting that strength may not always be a prerequisite for movement re-education.¹³ Not surprisingly, a recent study has found the combination of strengthening exercises and movement reeducation to be the more effective approach in achieving favorable outcomes.⁹ Indeed, the authors of the 2 case reports in this issue utilize this combined approach resulting in successful recovery through a 1 year follow-up with a full return to sport-related activities.^{29,32} Certainly, well-controlled clinical trials are needed to better define treatment strategies required to achieve optimal clinical outcomes.

It should be noted that the majority of investigations into these knee injuries have focused on females. While this is likely due, in part, to the greater incidence of these injuries in females and, thus a faster rate of subject enrollment, biomechanical differences between genders cannot be discounted. Substantial differences in hip joint motion and muscle activation patterns during walking and running have been reported between non-injured males and females.³ Further, trunk and pelvis proprioception³⁵ and hip strength¹⁵ deficits have been found in females but not males with lower extremity injuries. Therefore, additional study is certainly warranted to better define if gender-specific mechanisms exist. However, this should not prevent us from considering hip muscle strength and neuromuscular control strategies in the management of males with overuse hip and knee injuries, as illustrated in the 2 case reports in this issue of JOSPT.^{29,32}

This special issue of the *Journal* provides a compilation of papers focused on further defining the contribution of proximal factors to knee/lower extremity injury. In 2 separate contributions, detailed summaries of the muscle mechanics³³ and kinesiology¹⁷ of the hip are presented, providing a foundation from which clinical application can evolve. In a separate manuscript, this information is integrated to develop the conceptual basis for the potential role abnormal hip mechanics may have on both overuse (patellofemoral pain and iliotibial band syndromes) and traumatic (anterior cruciate ligament sprain) knee injuries.²³ Original research papers are included that demonstrate differences in hip mechanics during running in females with a history of tibial stress fracture¹² or iliotibial band syndrome.⁵ Finally, incorporating these concepts into clinic practice, novel case reports involving individuals with piriformis syndrome²⁹ and recurrent hamstring cramping³² are presented; as well as a clinical commentary describing the management of hamstring strain injuries with an emphasis on achieving dynamic stability of the lumbopelvic and hip regions.⁷ Collectively, we hope these papers will provide direction to both patient care and patient-related research.

Any of us would be amiss not to recognize the influences the lumbopelvic and hip regions have on knee loading and therefore potentially knee injury. However, consideration of these regions should be made in addition to, not at the expense of, other contributing factors, such as patellar alignment, quadriceps strength, foot posture, and fear-avoidance beliefs;^{21,22} as it is improbable that any one cause can account for all episodes of knee injury. It is only through this approach that we may begin to identify specific clinical characteristics that can best direct the care and management of the individual.

References

1. Bolgia LA, Malone TR, Umberger BR, Uhl TL. Hip strength and hip and knee kinematics during stair descent in females with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther* 2008;38:12–18. [PubMed: 18349475]
2. Boling MC, Padua DA, Marshall SW, Guskiewicz K, Pyne S, Beutler A. A prospective investigation of biomechanical risk factors for patellofemoral pain syndrome: the Joint Undertaking to Monitor and Prevent ACL Injury (JUMP-ACL) cohort. *Am J Sports Med* 2009;37:2108–2116. [PubMed: 19797162]
3. Chumanov ES, Wall-Scheffler C, Heiderscheit BC. Gender differences in walking and running on level and inclined surfaces. *Clin Biomech (Bristol, Avon)* 2008;23:1260–1268.
4. Collins N, Crossley K, Beller E, Darnell R, McPoil T, Vicenzino B. Foot orthoses and physiotherapy in the treatment of patellofemoral pain syndrome: randomised clinical trial. *Br J Sports Med* 2009;43:169–171. [PubMed: 19270165]
5. Ferber R, Noehren B, Hamill J, Davis I. Competitive female runners with a history of iliotibial band syndrome demonstrate atypical hip and knee kinematics. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
6. Fredericson M, Cookingham CL, Chaudhari AM, Dowdell BC, Oestreicher N, Sahrmann SA. Hip abductor weakness in distance runners with iliotibial band syndrome. *Clin J Sport Med* 2000;10:169–175. [PubMed: 10959926]
7. Heiderscheit BC, Sherry MA, Silder A, Chumanov ES, Thelen DG. Hamstring strain injuries: Recommendations for diagnosis, rehabilitation and injury prevention. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
8. Henriksen M, Aaboe J, Simonsen EB, Alkjaer T, Bliddal H. Experimentally reduced hip abductor function during walking: Implications for knee joint loads. *J Biomech* 2009;42:1236–1240. [PubMed: 19368926]
9. Herman DC, Onate JA, Weinhold PS, et al. The effects of feedback with and without strength training on lower extremity biomechanics. *Am J Sports Med* 2009;37:1301–1308. [PubMed: 19299530]
10. Leetun DT, Ireland ML, Willson JD, Ballantyne BT, Davis IM. Core stability measures as risk factors for lower extremity injury in athletes. *Med Sci Sports Exerc* 2004;36:926–934. [PubMed: 15179160]
11. Miller RH, Meardon SA, Derrick TR, Gillette JC. Continuous relative phase variability during an exhaustive run in runners with a history of iliotibial band syndrome. *J Appl Biomech* 2008;24:262–270. [PubMed: 18843156]
12. Milner CE, Hamill J, Davis I. Distinct hip and rearfoot kinematics in female runners with a history of tibial stress fracture. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
13. Mizner RL, Kawaguchi JK, Chmielewski TL. Muscle strength in the lower extremity does not predict postinstruction improvements in the landing patterns of female athletes. *J Orthop Sports Phys Ther* 2008;38:353–361. [PubMed: 18515963]
14. Myer GD, Chu DA, Brent JL, Hewett TE. Trunk and hip control neuromuscular training for the prevention of knee joint injury. *Clin Sports Med* 2008;27:425–448. ix. [PubMed: 18503876]
15. Nadler SF, Malanga GA, DePrince M, Stitik TP, Feinberg JH. The relationship between lower extremity injury, low back pain, and hip muscle strength in male and female collegiate athletes. *Clin J Sport Med* 2000;10:89–97. [PubMed: 10798789]
16. Nakagawa TH, Muniz TB, Baldon Rde M, Dias Maciel C, de Menezes Reiff RB, Serrao FV. The effect of additional strengthening of hip abductor and lateral rotator muscles in patellofemoral pain syndrome: a randomized controlled pilot study. *Clin Rehabil* 2008;22:1051–1060. [PubMed: 19052244]
17. Neumann DA. Kinesiology of the hip: a focus on muscular actions. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
18. Nicholas JA, Strizak AM, Veras G. A study of thigh muscle weakness in different pathological states of the lower extremity. *Am J Sports Med* 1976;4:241–248. [PubMed: 12667]

19. Niemuth PE, Johnson RJ, Myers MJ, Thieman TJ. Hip muscle weakness and overuse injuries in recreational runners. *Clin J Sport Med* 2005;15:14–21. [PubMed: 15654186]
20. Noehren B, Davis I, Hamill J. ASB clinical biomechanics award winner 2006 prospective study of the biomechanical factors associated with iliotibial band syndrome. *Clin Biomech (Bristol, Avon)* 2007;22:951–956.
21. Piva SR, Fitzgerald GK, Irrgang JJ, et al. Associates of physical function and pain in patients with patellofemoral pain syndrome. *Arch Phys Med Rehabil* 2009;90:285–295. [PubMed: 19236982]
22. 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. [PubMed: 19565153]
23. Powers CM. The influence of abnormal hip mechanics on knee injury: a biomechanical perspective. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
24. Rutherford DJ, Hubley-Kozey C. Explaining the hip adduction moment variability during gait: Implications for hip abductor strengthening. *Clin Biomech (Bristol, Avon)* 2009;24:267–273.
25. Shultz SJ, Nguyen AD, Leonard MD, Schmitz RJ. Thigh strength and activation as predictors of knee biomechanics during a drop jump task. *Med Sci Sports Exerc* 2009;41:857–866. [PubMed: 19300140]
26. Sigward SM, Ota S, Powers CM. Predictors of frontal plane knee excursion during a drop land in young female soccer players. *J Orthop Sports Phys Ther* 2008;38:661–667. [PubMed: 18978451]
27. Souza RB, Powers CM. Predictors of hip internal rotation during running: an evaluation of hip strength and femoral structure in women with and without patellofemoral pain. *Am J Sports Med* 2009;37:579–587. [PubMed: 19098153]
28. Thijs Y, Van Tiggelen D, Willems T, De Clercq D, Witvrouw E. Relationship between hip strength and frontal plane posture of the knee during a forward lunge. *Br J Sports Med* 2007;41:723–727. discussion 727. [PubMed: 17601767]
29. Tonley JC, Yun SM, Kochevar RJ, Dye JA, Farrokhi S, Powers CM. Treatment of an individual with piriformis syndromes focusing on hip muscle strengthening and movement re-education: a case report. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
30. van Linschoten R, van Middelkoop M, Berger MY, et al. Supervised exercise therapy versus usual care for patellofemoral pain syndrome: an open label randomised controlled trial. *BMJ* 2009;339:b4074. [PubMed: 19843565]
31. 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*. Dec 3;2008 Epub ahead of print.
32. Wagner T, Behnia N, Ancheta WL, Shen R, Farrokhi S, Powers CM. Strengthening and neuromuscular re-education of the gluteus maximus in a triathlete with exercise-associated cramping of the hamstrings: a case report. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
33. Ward SR, Winters T, Blemker SS. The architectural design of the gluteal muscle group: implications for movement and rehabilitation. *J Orthop Sports Phys Ther* 2010;XX:XX–XX.
34. Willson JD, Binder-Macleod S, Davis IS. Lower extremity jumping mechanics of female athletes with and without patellofemoral pain before and after exertion. *Am J Sports Med* 2008;36:1587–1596. [PubMed: 18448577]
35. Zazulak BT, Hewett TE, Reeves NP, Goldberg B, Cholewicki J. The effects of core proprioception on knee injury: a prospective biomechanical-epidemiological study. *Am J Sports Med* 2007;35:368–373. [PubMed: 17267766]