Hamstring Strains; Is an MRI necessary?

Comparing MRI with clinical assessment in AFL footballers with a hamstring strain.

By Price Warren

A standard clinical assessment of an acute mild or moderate hamstring strain provides a more accurate diagnosis and estimation of the severity of injury than MRI investigation.

This is a clinical sports medicine review paper of a study (Am Jnl Sports Med, 34 (6), 2006, 1008- 1015) where a physical examination consisting of 2 flexibility tests, a manual muscle test, an active slump test and palpation was compared to an MRI investigation in hamstring injured AFL footballers examined within three days of injury. While many physicians evaluating hamstring strains at AFL clubs utilise an MRI to support their diagnosis and management of the injury, this was the first research paper comparing how MRI compares to the clinical evaluation in confirming the diagnosis and establishing the severity or potential duration of rehabilitation required. In 34% of hamstring strains where the clinical and MRI prognosis differed, often significantly, the clinical assessment was more accurate in every case than that of the MRI.

While both clinical examination and MRI findings correlated reasonably well with the actual time required to return to competition and the correlation between them was moderate this study showed that MRI is not required for estimating the duration of rehabilitation of an acute hamstring strain in elite footballers.

Hamstring strains are the most common injury in the AFL.

In the Australian Football League (AFL), the elite level of competition, hamstring strains are the most common injury, resulting in the greatest number of lost playing days [1]. The recurrence rates for hamstring strain are also high. Greater than 30% of hamstring strains in the AFL recur within the season, despite concentrated rehabilitation and prevention efforts [1].

This is one of the reasons that physicians evaluating hamstring strains in professional footballers utilise magnetic resonance imaging (MRI) to support the clinical diagnosis and management of the injury.

Muscle injuries are usually imaged with either ultrasound, computerised tomography or MRI. MRI has been proposed as the preferred modality in recent years [2] and has offered a highly detailed imaging analysis of the extent of injury for elite athletes [3-8]. Sonography is equally as sensitive as MRI in assessing the presence of a hamstring injury in the acute stage, however, a more detailed analysis of the injury profile is achieved using MRI, particularly during the healing phase [2]. Both the longitudinal length of muscle injury on MR imaging [2], and the abnormal area, as measured in cross section are useful predictors for the time required to return to full competition [2,6]. In studies of elite Australian footballers MRI negative hamstring strains have a significantly faster rehabilitation interval compared with MRI positive strains [9, 10].

It is questionable whether the costs involved and the additional perceived benefits of imaging, in assessing the time of rehabilitation required are worthwhile in most cases for mild (grade 1) and moderate (grade 2) hamstring strains. The pain and restriction associated with such hamstring injuries usually resolve within a couple of weeks at most and players appear clinically without abnormality and, in most instances, resume training and competition soon thereafter. The underlying pathology may persist for several weeks longer [7] with persistent injury demonstrated by MRI, at times, many weeks after players have successfully returned to competition [2]. Is the assessment of the presence and degree of pain and restriction as measured during a clinical assessment an equal or better indicator of the prognosis than radiological findings using MRI?

With little information available to assess how MRI compared to the clinical evaluation in establishing the duration of rehabilitation required for a hamstring strain this study was undertaken with the aim to a) compare estimates of rehabilitation duration based on either a clinical diagnosis or based on MRI findings with the actual time required to return to competition and b) to analyse the level of agreement between clinical and radiological assessment with regard to presence or absence of injury.

Fifty-eight AFL footballers with a hamstring strain underwent a clinical assessment and an MRI within 3 days of injury.

The players, identified from the 10 Victorian based AFL clubs during the 2002 season, were examined using a 1.5T superconducting unit (Sigma LX, GE Medical Systems, Milwaukee, Wis) with a phased-array surface coil (Shoulder Array; Medrad, Indianola, Pa) strapped over the thigh centred over the region of maximal tenderness. The injured area was identified and the following six radiological measures assessed: injured muscle(s) involved, site(s) of injury within the muscle unit, injured area (% cross-section), length of injured area (mm), and presence of intermuscular and intramuscular haematoma. MRI findings were considered abnormal if abnormal signal intensity or echotexture could be detected. If more than one muscle was injured, the muscle with the

greater area of signal or echotexture abnormality was considered the primary site of injury and assessment criteria were taken for that particular muscle.

An experienced musculoskeletal radiologist interpreted the MRI scans and recorded the pathology characteristics including the length of injury as observed on coronal views. An estimation of the recovery time was made for each case. Recovery time was defined as the number of days from the initial injury until return to competition.

Following MR imaging, the players underwent a clinical assessment conducted by an independent experienced physiotherapist who was blinded to the radiological findings. The clinical assessment consisted of five tests assessing hamstring flexibility, neural mobility, pain provocation and site of the injury. The tests selected were commonly used clinically[11], referenced in the literature [12-14] and reliable [11, 15, 16].

The passive straight leg raise (PSLR) test provided an indication of hamstring muscle length (17) with the knee in full extension. The active knee extension (AKE) test is another measure of hamstring muscle length taken in a position of 90º hip flexion (Figure1). The reliability of the tests had been established by Gabbe et.al 16 and the method described by these authors was used. The active slump test assessed pain-sensitive neuromeningeal structures that have been suggested as a potential source of pain in the posterior thigh in hamstring injuries [18-21]. A test of pain provocation evaluated whether the hamstring pain could be elicited by isometric contraction of the hamstring muscles. This was performed in prone lying with 15 degrees knee flexion and then repeated with the knee in 90º flexion. The examiner also palpated the hamstrings in prone lying to locate the region relating to the player's pain.

Figure 1. Active Knee Extension

If at least one positive finding was demonstrated during any of the PSLR, AKE, and manual muscle tests, the player was classified as having a hamstring injury. The active slump test finding was used as additional information in cases where the other clinical tests were negative with the suggestion that adverse neural tension may be the source of the players' inability to continue training or playing. Criteria for grading of the injuries were based on the description by Oakes [11]. Correlation between successful return to competition and clinical and radiological findings were carried out.

The median (range) time from injury until examination was 2 (0-3) days. The mean (range) age of the players was 24 (17-33) years while the mean (range) height and weight was 186 (174-200) cm and 88 (74-107) kg, respectively. The time taken to return to competition ranged from one to 8 weeks with a median of 26 days. Twenty-six players (44%) returned to competition within three weeks.

Equivalent diagnoses were made in 38 of the 58 cases (65%). In 18 cases (31%) players recorded pain and/or painfully reduced flexibility during the clinical examination but there was no injury demonstrated on the MRI. In contrast, two cases (3%) showed significant injury on MRI, but the clinical tests were carried out without eliciting any pain or reduced flexibility.

The duration of rehabilitation based on both the clinical assessment and the MRI significantly correlated with actual time to successfully return to competition. The correlation coefficient of the radiological estimation of the rehabilitation period was lower, but still correlated well with the actual time taken to return to competition. The correlation coefficient between clinical estimates of rehabilitation and MRI was moderate.

The clinical analysis performed better than MRI in estimating the time required to return to competition. Where the MRI and clinical prognosis differed the physiotherapy assessment was more accurate in every case.

In 20 of the 58 cases investigated (34%), the clinical and radiological diagnoses disagreed with regard to the presence or absence of injury. In 2 cases clinical assessment indicated minimal signs of injury in the hamstring muscle complex, but extensive muscle fibre damage was seen on MRI. The first player had an injury to the biceps femoris involving 80 mm of muscle suggesting a significant injury, with mild intermuscular hemorrhage, as well as a chronic injury to the semitendinosus (Figure 2). This player had no abnormality with active slump testing, was pain free several days after the injury, and returned to competition 14 days after the assessment. During his first competitive game, prior to which he had completed 3 full training sessions, he re-injured the biceps femoris at the same location identified on MRI 2 weeks earlier. Clinical tests in the second player similarly suggested a mild hamstring strain, this time to the semitendinosus. On MRI, however, he had a 100-mm-long injury to the semimembranosus muscle at the musculotendinous junction (Figure 3) suggesting a rehabilitation period of at least 3 weeks. This player returned to competition 13 days after injury and remained injury free for the remainder of the season.

In the other 18 hamstring strains where the MRI result disagreed with the clinical assessment the MRI examination revealed no intramuscular hyperintensity suggesting muscle fiber damage or injury. Clinical testing in all cases except one in this group suggested the presence of mild injury. Eight of those players were able to return to competition within 1 week; 4 within 2 weeks; and 1 at 3 weeks. The one exception in this group was a player who was classified with a moderate injury to the biceps femoris on the basis of the clinical assessment, with a predicted rehabilitation period of at least 21 days. This player returned to competitive play 28 days after the injury. The MRI scan demonstrated no abnormality. This player had no

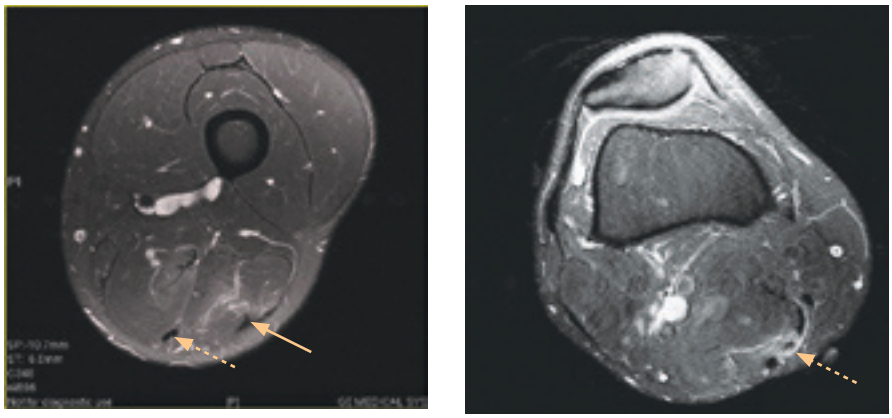

Figure 2.

Moderate-grade hamstring injury in a 26-year-old elite AFL footballer in the upper third of the thigh. Axial MRI obtained 2 days after injury demonstrates a recent injury of the biceps femoris (solid arrow). Scar tissue (dashed arrow) surrounding the semitendinosus tendon indicates a chronic injury. A small amount of edema is present, suggestive of an injury that occurred about 6 to 10 weeks before scanning. This player was classified as injury free as a result of the clinical assessment, returned to competition after 3 full training sessions at 14 days post injury, and re-injured the same muscle during his first game back.

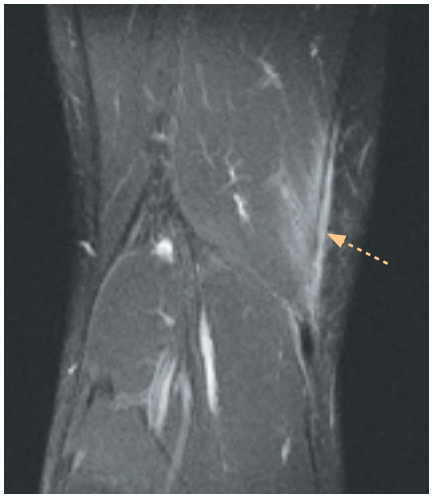

Figure 3.

Moderate-grade hamstring injury in a 25-year-old elite AFL footballer presenting with suspected hamstring strain on the day of injury. Axial MRI (A) demonstrates injury to the semimembranosus muscle with mild intermuscular hemorrhage (arrow). The coronal view of injury (B) showed hyperintensity extending over approximately 100 mm of the semimembranosus muscle (arrow). Clinical evaluation of this player revealed no abnormality, he returned to competition after 13 days, and he remained free from further hamstring injuries for the remainder of the season (5 months).

abnormality on active slump testing suggesting that the relatively slow return to competition was more likely due to intrinsic hamstring injury rather than, for example, referred pain.

In 3 other studies where hamstring strains were examined by MRI, 18%, 19%, and 45% of posterior thigh pain, clinically diagnosed as a hamstring strain, was without abnormality on MRI [5,8,10]. Lower back-related nerve impingement was suggested as a cause of hamstring pain and stiffness in one study [18], where previous back injury was identified as a significant risk factor for hamstring-related injuries. While this study had only 31 participants, in those players with a negative MRI result, length of rehabilitation was significantly shorter (6.6 days) than in the group with a positive MRI result (20.2 days), indicating that a positive MRI result was a good indicator of time required to return to full training.

Eight players with a negative MRI result returned to competition after 1 week and did not record a further hamstring injury for the remainder of the season, an outcome similar to that reported in the MRI study by Gibbs et al [9]. In contrast, those players with a positive MRI result needed almost twice the time for successful rehabilitation (22.9 days).

MRI performs better in moderately severe hamstring injury than in cases of mild injury.

While the results of this study demonstrate that both a clinical and a radiological evaluation of a hamstring injury can be useful predictors of the duration of rehabilitation required the clinical evaluation is more accurate than MRI. MRI performed better in cases with more serious injuries, those with an injured area >60 mm in length or >10% on cross section. In those cases, the correlation between estimated and actual recovery was high, whereas mild injuries appear difficult to evaluate using MRI with regard to duration of recovery. Clinical tests were significantly more accurate in estimating recovery times in mild injuries.

The absence of injury on MRI does not rule out a mild strain and MRI confirmation of injury, particularly with an injured area >60 mm in length or >10% on cross section, combined with clinical assessment suggesting a moderate strain confirms a greater than 3 week duration of rehabilitation. However, on the basis of this study, there is no indication for MRI investigation of an acute mild or moderate hamstring strain.

The outcomes reported in this study should provide valuable guidance to physiotherapists and doctors working with professional football players, as well as other footballers and athletes with hamstring strains.

Acknowledgement

The Australian Football League is acknowledged for financial support of this study.

The full results of this AFL funded scientific study have been published in the American Journal of Sports Medicine, Volume 34, Number 6, June 2006, Pages 1008- 1015. Price Warren was invited to participate as the clinical examiner; he had previously been an AFL club physiotherapist for 11 seasons and was, at that time, not associated with any club. He carried out a survey of AFL physiotherapists and members of Sports Physiotherapy Australia which revealed the most popular clinical

examination techniques for a hamstring strain. The results of this survey, plus clinical examination techniques used in the literature, particularly those associated with reliability studies, formed the basis of the clinical assessment used in this study. The results of further analysis; "Clinical Predictors of Return to Competition and of Recurrence following Hamstring Strain in Elite AFL Footballers" (Master of Physiotherapy Thesis) suggest that the physiotherapy assessment can be improved, resulting in greater accuracy in predicting both the duration of rehabilitation required for a hamstring strain and the likelihood of a recurrence.

References

1. Orchard J, Seward H. Epidemiology of injuries in the Australian Football League, seasons1997-2000. British Journal of Sports Medicine 2002;36(1):39-45.
2. Connell DA, Schneider-Kolsky ME, Hoving JL, Malara F, Buchbinder R, Koularis G, et al. A longitudinal study comparing sonographic and MR imaging assessment of acute and healing hamstring injuries. American Journal of Sports Medicine 2004;34(6):1008-1015.
3. Brandser EA, El-Khoury GY, Kathol MH, Callaghan JJ, Tearse DS. Hamstring Injuries: Radiographic, Conventional Tomographic, Ct and MR imaging characteristics. Radiology 1995;179:257-262.
4. De Smet AA, Best TM. MR Imaging of the Distribution and Location of Acute Hamstring Injuries in Athletes. American Journal of Roentgenology 2000;174:393-399.
5. Speer K, Lohnes J, Garrett WE. Radiographic imaging of muscle strain injury. The American Journal of Sports Medicine 1993;21:89-96.
6. Slavotinek JP, Verrall GM, Fon GT. Hamstring Injury in Athletes: Using MR Imaging Measurements to compare extent of muscle injury with amount of time lost from competition. American Journal of Roentgenology 2002;179:1621-1628.
7. Kirkendall DT, Garrett WE, Jnr. The Effects of Aging and Training on Skeletal Muscle. The American Journal of Sports Medicine 1998;26(4):598-602.
8. Koulouris G, Connell DA. Evaluation of the hamstring muscle complex following acute injury. Skeletal Radiology 2003;32(10):582-589.
9. Gibbs N, Cross T, Cameron M, Houang M. The accuracy of MRI in predicting recovery and recurrence of acute grade one hamstring muscle strains within the same season in Australian Rules football players. Journal of Science and Medicine in Sport 2004;7(2):248-58.
10. Verrall GM, Slavotinek JP, Barnes PG, Fon GT. Diagnostic and prognostic value of clinical findings in 83 athletes with posterior thigh injury: comparison of clinical findings with magnetic resonance imaging documentation of hamstring muscle strain. The American Journal of Sports Medicine 2003;31(6):969-73.
11. Sullivan MK, Dejulia JJ, Worrell TW. Effect of pelvic position and stretching technique on hamstring muscle length. Medicine and Science in Sports and Exercise 1992;24:1383-1389.
12. Malliaropoulos N, Papalexandris S, Papalada A, Papacostas E. The Role of Stretching in Rehabilitation of Hamstring Injuries: 80 Athletes Follow-Up. Medicine and Science in Sports and Exercise 2004;36(5):756-759.
13. Hennessy L, Watson AWS. Flexibility and posture assessment in relation to hamstring injury. British Journal of Sports Medicine 1993;27(4):243-247.
14. Brown A, Salmond S, Maxwell L. Asessment of hamstring flexibility which test? New Zealand Journal of Physiotherapy 1993;December:33-34.
15. Gadjosik R, Lusin G. Hamstring muscle tightness. Physical Therapy. 1983;63(7):1085-89.
16. Gabbe BJ, Bennell KL, Wajswelner H, Finch CF. Reliability of common lower extremity musculoskeletal screening tests. Physical Therapy in Sport. 2004;5:90-97.
17. Gadjosik RL. Passive extensibility of skeletal muscle: review of the literature with clinical implications. Clinical Biomechanics 2001;16:87-101.
18. Kornberg C, Lew P. The effect of stretching neural structures on grade one hamstring injuries. The Journal of Orthopaedic and Sports Physical Therapy. 1989;10:481-487.
19. Massey A. The Slump Test : an investagation of the movement of pain sensitive structures in the vertebral canal in subjects with low back pain. In: Postgraduate Diploma Dissertation. Adelaide; 1982.
20. Maitland G. Vertebral Manipulation, 5th edition: Butterworth & Co; 1986.
21. Turl SE, George KP. Adverse neural tension: a factor in repetitive hamstring strain? Journal of Orthopaedic & Sports Physical Therapy. 1998;27(1):16-21.

Centre for Health, Exercise and Sports Medicine, School of Physiotherapy, University of Melbourne, Melbourne, Australia

Richmond Physiotherapy Clinic, 361 Church St, Richmond 3121, Melbourne, Australia

Price Warren is an APA Titled Sports Physiotherapist, Master of Physiotherapy (Research-Hamstring injuries in AFL football), an AFL club physiotherapist, and long term SMA and SPA member. This is a clinical summary of a paper published in the American Journal of Sports Medicine, Volume 34, Number 6, June 2006, Pages 1008- 1015.

Correspondence: price@richmondphysiotherapyclinic.com.au

Australian College of Sports Physicians (ACSP)

Upcoming events

ACSP Clinical Sports Medicine 2009 Conference
Sydney
28 February – 1 March 2009
Comprehensive seminar presented by sports physicians. Topics to be covered include:

- The female athlete
- Heat stress in sport
- Concussion in children and adults
- Exercise and the metabolic syndrome
- Diving medicine
- Hyperbaric chambers
- Advances in soft tissue injury management
- Workshops on a range of lumbar spine, pelvis, SIJ, hip and groin pathology for recreational and elite sports people.

Registration open to Medical Practitioners and Allied Health Professionals.
Early Bird registration closes 31 December 2008.

For more visit www.acsp.org.au

Decision on Recognition of Medical Specialties
The Minister for Health and Ageing, the Hon Tony Abbott MHR, has decided that a case has been made for recognising the discipline of **Sport and Exercise Medicine** as a medical specialty. This follows advice on the matter from the AMC. This completes Stage 1 of the AMC recognition process.

This decision does not automatically lead to the inclusion of the specialty on Schedule 4 of the *Health Insurance Regulations 1975*, which would grant patients access to rebates through *Medicare Australia*.

Applications for accreditation of specialist level training and education programs in this discipline may now be considered by the AMC. This is Stage 2 of the recognition process. It is important to note that such applications are not restricted to Stage 1 applicants. Any organisation believing that it might comply with AMC standards for the provision of training in these disciplines may apply.

For more visit www.acsp.org.au