Inter Limb Asymmetry in Athletic Groin Pain and Rugby Union Players

Shane Gore[1,2,3], Brendan Marshall[1,2,3], Chris Richter[1,2,3], Andrew Franklyn-Miller[1,5], Marit Undheim[1], Kieran Moran[2,3], Eanna Falvey[1]

[1]Sports Medicine Department, Sports Surgery Clinic, Santry Demesne, Dublin, Ireland
[2]School of Health and Human Performance, Dublin City University, Dublin, Ireland
[3]Insight Centre for Data Analytics, Dublin City University, Dublin, Ireland
[4]Department of Life Sciences, Roehampton University, London, UK
[5]Centre for Health, Exercise and Sports Medicine, University of Melbourne, Melbourne, Australia

This study compared levels of inter limb asymmetry between field sports players with athletic groin pain (n=15) and international rugby union players (n=15). Three dimensional kinematics and kinetics were recorded for the single leg drop landing and side cut movement. A series of t-tests identified significantly ($p<0.05$) greater asymmetry in hip abduction-adduction moments for the rugby union group during the single leg drop landing task. All other variables were non-significantly different between the groups examined. These results suggest that asymmetry may not be an important factor in the examination of athletic groin pain. Future studies should investigate if asymmetrical abduction-adduction hip moments are a risk factor for injury in rugby union.

KEYWORDS: athletic groin pain, rugby union, asymmetry.

INTRODUCTION: Inter limb asymmetry has been suggested to be a risk factor for lower extremity injury (Orchard, 2001 and Knapik *et al.,* 1991). According to Maulder *et al.,* (2013) this is due to dominance on one side, which can increase tissue specific stress as it is preferentially used for jumping, landing or pushing-off tasks. One common lower extremity injury is athletic groin pain, which occurs frequently in sports that involve dynamic movements (i.e acceleration, deceleration, and sudden direction change) such as rugby union (Brooks *et al.,* 2005). Furthermore, the morbidity level associated with athletic groin pain within rugby union means it is behind only fracture and joint reconstruction in terms of lost time from injury (Brooks *et al.,* 2005). To date however, no studies have investigated if kinematic and kinetic asymmetry is an important factor in chronic athletic groin pain.
Current methods of measuring inter limb asymmetry include isokinetic dynamometry, and jump and running tests. Whilst isokinetic testing has been used commonly in sports medicine, it has been widely criticised since it does not replicate sport specific movements (Mayer *et al.,* 2003) and may lack sensitivity to asymmetries (Menzel *et al.,* 2013). Field based sports contain a multitude of movements, including change of direction cutting and single leg landing tasks. As such a more comprehensive three dimensional (3D) assessment of sporting movements may provide a better insight into asymmetrical loading patterns. The aim of study was to compare the levels of asymmetry present in patients with athletic groin pain to rugby union players. It was hypothesized that the athletic groin pain group would demonstrate significantly greater asymmetries compared with the rugby union group.

METHODS: Recruited for this study were 15 athletic groin pain patients from Gaelic football (80%) and rugby union (20%) (mean ± *SD*; age, 27.8 ± 6.3 years, height, 180.2 ± 6.1 cm; mass, 81.1 ± 10.7 kg; time with groin pain, 56.8 ± 68.2 weeks) and 15 international rugby union players (mean ± SD: age 20.4 ± 1.0 years; height 186.2 ± 7.6cm; mass 98.4 ± 9.9kg), who underwent 3D biomechanical assessment. The international rugby union group contained both forward and back players who were injury free at the time of testing. The study was approved by the Sport Surgery Clinic Hospital Ethics Committee and all subjects signed informed consent. Testing involved three trials on each leg, for a single leg drop landing (30cm) and a running cut (75°) on an artificial grass surface (polyethylene mono filament, Condor Grass, Holland). An eight infrared camera 3D motion analysis system (Vicon - Bonita B10, UK), synchronized with two force platforms (AMTI – BP400600, USA), was used to collect kinematic and kinetic data. Reflective markers were placed at bony landmarks according to Plug in Gait marker locations (Vicon, UK). Both marker and force data were filtered using a fourth order Butterworth filter with a cut-off frequency of 15Hz (Bisseling and Hof, 2006). Standard inverse dynamics techniques (Winter, 2009) were employed to calculate segmental and joint mechanics. To examine asymmetries, hip, knee, and pelvis range of motion (ROM) were examined in all three movement planes for the drop landing, with the addition of trunk ROM for the side cut. Absolute peak moments were also examined at the hip and knee for the drop landing and side cut. The mean of each participant's three trials were used in the analysis. Normalised asymmetry was calculated between right and left leg for each participant within both groups as follows:

Normalised Asymmetry = (Max – Min) / [0.5 * (Max + Min)]

Independent t-tests with an alpha level of $p < 0.05$ were then carried out to determine if there were significant differences in normalised asymmetry between the groups.

RESULTS: The comparison of inter limb differences between rugby union and athletic groin pain groups are displayed in Table 1. In the single leg drop landing, the rugby union group demonstrated significantly greater asymmetry in hip abduction-adduction moments compared to the groin group ($p < 0.05$). All other variables displayed non significant differences.

Table 1: Comparison of normalised inter limb asymmetry between the rugby union (RU) and athletic groin pain (AGP) groups in the single leg drop landing (SLDL) and running cut.

Variable		Cut Mean ± SD RU	Cut Mean ± SD AGP	Cut %diff	Cut (p)	SLDL Mean ± SD RU	SLDL Mean ± SD AGP	SLDL %diff	SLDL (p)
Hip ROM (°)	flex-ext	0.20 ±0.2	0.25 ±0.2	*-18.8*	0.52	0.13 ±0.1	0.20 ±0.1	*-37.1*	0.08
	abd-add	0.20 ±0.2	0.35 ±0.3	*-41.8*	0.13	0.32 ±0.3	0.21 ±0.1	*+32.7*	0.22
	int-ext rot	0.28 ±0.2	0.31 ±0.3	*-11.1*	0.66	0.43 ±0.3	0.55 ±0.4	*-21.6*	0.39
Knee ROM (°)	flex-ext	0.20 ±0.1	0.20 ±0.2	*+1.8*	0.96	0.09 ±0.1	0.11 ±0.1	*-20.5*	0.54
	abd-add	0.14 ±0.1	0.28 ±0.2	*-50.6*	0.07	0.38 ±0.3	0.39 ±0.3	*-1.8*	0.95
	int-ext rot	0.26 ±0.2	0.39 ±0.3	*-33.2*	0.13	0.33 ±0.2	0.24 ±0.2	*+25.7*	0.33
Pelvis ROM (°)	tilt	0.25 ±0.2	0.39 ±0.3	*-36.7*	0.11	0.37 ±0.3	0.54 ±0.3	*-31.7*	0.16
	obliquity	0.26 ±0.3	0.35 ±0.2	*-26.6*	0.31	0.29 ±0.2	0.22 ±0.1	*+24.9*	0.15
	int-ext rot	0.28 ±0.3	0.33 ±0.3	*-14.8*	0.66	0.44 ±0.4	0.36 ±0.3	*+19.1*	0.51
Thorax ROM (°)	flex-ext	0.25 ±0.1	0.40 ±0.3	*-38.3*	0.13	.	.	.	.
	abd-add	0.27 ±0.3	0.24 ±0.2	*+7.9*	0.80	.	.	.	.
	int-ext rot	0.25 ±0.2	0.41 ±0.3	*-38.8*	0.14	.	.	.	.
Hip peak moment (N.m/kg)	flex-ext	0.35 ±0.3	0.33 ±0.2	*+4.9*	0.87	0.27 ±0.2	0.17 ±0.1	*+37.4*	0.10
	abd-add	0.29 ±0.3	0.23 ±0.2	*+25.5*	0.48	0.29 ±0.2	0.14 ±0.1	*+50.9*	*****0.01
	int-ext rot	0.41 ±0.3	0.38 ±0.3	*+7.0*	0.80	0.19 ±0.1	0.21 ±0.1	*-8.8*	0.74
Knee peak moment (N.m/kg)	flex-ext	0.20 ±0.2	0.20 ±0.1	*-1.7*	0.96	0.13 ±0.1	0.17 ±0.1	*-21.1*	0.38
	abd-add	0.48 ±0.3	0.35 ±0.3	*+27.6*	0.28	0.19 ±0.2	0.18 ±0.1	*+9.3*	0.74
	int-ext rot	0.26 ±0.2	0.42 ±0.3	*-61.4*	0.07	0.25 ±0.2	0.32 ±0.1	*-21.6*	0.51

*Significant difference ($p < 0.05$), percentage difference ('+' rugby union greater, '-' athletic groin pain greater).

DISCUSSION: Inter limb asymmetries have previously been used to predict injury [eg. anterior cruciate ligament (Paterno *et al.,* 2010) and hamstring strain injury (Croisier *et al.,* 2002)]. Despite this, its importance in the area of athletic groin pain has not to date been assessed. In this study, the normalised inter limb differences between an athletic groin pain group and an elite rugby union group was compared. In the single leg drop landing, the rugby union group demonstrated significantly greater asymmetries in hip abduction-adduction moments. Contrary to the hypothesis, with the exception of this variable, there were no other significant differences between the groups. This implies that asymmetry in predominantly single leg tasks may not be an important consideration in the examination of athletic groin pain.

Whilst these findings may at first seem counter intuitive, it has been previously demonstrated that elite athletes display significant levels of inter limb asymmetry in sports such as soccer (Rahnama *et al.,* 2005, McLean *et al.,* 1993 and Zahalka *et al.,* 2013) and rowing (Buckeridge *et al.,* 2014). In fact, in comparison to 'normal' healthy individuals, elite athletes may have greater levels of asymmetry. This was previously demonstrated by Schiltz *et al.,* (2009) who compared professional basketball players to junior level basketball players and healthy males. The tests investigated by Schiltz *et al.,* (2009) included a single-leg drop jump, 10 second repeated 1 legged hops and isokinetic strength measures. Interestingly, the professional players were significantly more asymmetric in all measures. Also it is important to note that players presenting leg asymmetries may not necessarily incur an injury. It is likely that asymmetries present in elite populations are due to a neuromuscular training effect caused by the greater volume of training associated with elite level (Smith, 2003) and leg dominance in repetitive asymmetric tasks.

Furthermore, as noted by Hewitt *et al.,* (2012) players without inter limb asymmetries are certainly not exempt from injury. Indeed in this study, the athletic groin pain group could be considered as symmetrical in comparison to international level rugby union players. This lack of asymmetry in the athletic groin pain group was unexpected due its association with other sporting injuries (eg. Paterno *et al.,* 2010 and Croisier *et al.,* 2002). It is possible, that greater differences may have been identified comparing the athletic groin pain group to recreational athletes rather than elite (Schiltz *et al.,* 2009). Alternatively, the use of pre selected discrete data points may have resulted in discarding important information regarding the difference in asymmetry between the examined groups (Richter et al., 2013). Future studies should investigate these possibilities.

CONCLUSION: Overall, in this present study the athletic groin pain group could be considered slightly more symmetrical in comparison to international level rugby union players. As such these results suggest that asymmetry may not be an important factor in the examination of athletic groin pain. Future research should investigate if asymmetrical hip moments are a risk factor for injury in rugby union.

REFERENCES:

Bisseling, R. W., & Hof, A. L. (2006). Handling of impact forces in inverse dynamics. *Journal of biomechanics*, *39*(13), 2438-2444.

Brooks, J. H., Fuller, C. W., Kemp, S. P. T., & Reddin, D. B. (2005). Epidemiology of injuries in English professional rugby union: part 1 match injuries. *British Journal of Sports Medicine*, *39*(10), 757-766.

Buckeridge, E. M., Bull, A. M., & McGregor, A. H. (2014). Foot force production and asymmetries in elite rowers. *Sports Biomechanics*, (ahead-of-print), 1-15.

Croisier, J. L., Forthomme, B., Namurois, M. H., Vanderthommen, M., & Crielaard, J. M. (2002). Hamstring muscle strain recurrence and strength performance disorders. *The American Journal of Sports Medicine*, *30*(2), 199-203.

Hewit, J., Cronin, J., & Hume, P. (2012). Multidirectional leg asymmetry assessment in sport. *Strength & Conditioning Journal*, *34*(1), 82-86.

Knapik, J. J., Bauman, C. L., Jones, B. H., Harris, J. M., & Vaughan, L. (1991). Preseason strength and flexibility imbalances associated with athletic injuries in female collegiate athletes. *The American Journal of Sports Medicine*, *19*(1), 76-81.

Maulder, P. S. (2013). Dominant limb asymmetry associated with prospective injury occurrence. *South African Journal for Research in Sport, Physical Education & Recreation (SAJR SPER)*, *35*(1).

Mayer, F., Schlumberger, A., Van Cingel, R., Henrotin, Y., Laube, W., & Schmidtbleicher, D. (2003). Training and testing in open versus closed kinetic chain. *Isokinetics and exercise science*, *11*(4), 181-187.
McLean, B. D., & Tumilty, D. M. (1993). Left-right asymmetry in two types of soccer kick. *British Journal of Sports Medicine*, *27*(4), 260-262.
Menzel, H. J., Chagas, M. H., Szmuchrowski, L. A., Araujo, S. R., de Andrade, A. G., & de Jesus-Moraleida, F. R. (2013). Analysis of Lower Limb Asymmetries by Isokinetic and Vertical Jump Tests in Soccer Players. *The Journal of Strength & Conditioning Research*, *27*(5), 1370-1377.
Orchard, J. W. (2001). Intrinsic and Extrinsic Risk Factors for Muscle Strains in Australian Football Neither the author nor the related institution has received any financial benefit from research in this study. *The American Journal of Sports Medicine*, *29*(3), 300-303.
Paterno, M. V., Schmitt, L. C., Ford, K. R., Rauh, M. J., Myer, G. D., Huang, B., & Hewett, T. E. (2010). Biomechanical measures during landing and postural stability predict second anterior cruciate ligament injury after anterior cruciate ligament reconstruction and return to sport. *The American journal of sports medicine*, *38*(10), 1968-1978.
Rahnama, N., Lees, A., & Bambaecichi, E. (2005). A comparison of muscle strength and flexibility between the preferred and non-preferred leg in English soccer players. *Ergonomics*, *48*(11-14), 1568-1575.
Richter, C., O'Connor, N. E., Marshall, B., & Moran, K. (2013). Analysis of Characterizing Phases on Waveforms – An Application to Vertical Jumps. Journal of Applied Biomechanics (in Press).
Schiltz, M., Lehance, C., Maquet, D., Bury, T., Crielaard, J. M., & Croisier, J. L. (2009). Explosive strength imbalances in professional basketball players.*Journal of athletic training*, *44*(1), 39.
Smith, D. J. (2003). A framework for understanding the training process leading to elite performance. *Sports medicine*, *33*(15), 1103-1126.
Williams, S., Trewartha, G., Kemp, S., & Stokes, K. (2013). A meta-analysis of injuries in senior men's professional Rugby Union. *Sports medicine*, *43*(10), 1043-1055.Brooks, J. H., Fuller, C. W., Kemp, S. P. T., & Reddin, D. B. (2005). Epidemiology of injuries in English professional rugby union: part 1 match injuries. *British Journal of Sports Medicine*, *39*(10), 757-766.
Winter DA. *Biomechanics and motor control of human movement*. 4th rev edn. New Jersey: J. Wiley, 2009.
Zahalka, F., Maly, T., Mala, L., Teplan, J., Gryc, T., Vaidova, E., ... & Buzek, M. (2013). Elite soccer's lower limbs explosive strength asymmetry. *British journal of sports medicine*, *47*(10), e3-e3.

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