A COMPARISON OF ASYMMETRY IN ATHLETIC GROIN PAIN PATIENTS AND ELITE RUGBY UNION PLAYERS USING ANALYSIS OF CHARACTERISING PHASES

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This study compared levels of inter limb asymmetry between field sports players with athletic groin pain and international rugby union players. Three dimensional kinematics and kinetics were recorded for the single leg hurdle hop and side cut movement. Analysis of characterising phases was utilised to identify significant differences in asymmetry between the two groups. The rugby union group had significantly greater asymmetry in some kinematic variables and hip kinetic variables at the beginning of the exercises. Overall however, the athletic groin pain group displayed greater asymmetry, particularly in hip moments compared with the rugby union group. These results suggest that an aspect of rehabilitation for athletic groin pain should focus on reducing asymmetric hip moments.

KEYWORDS: asymmetry, continuous analysis, groin pain

INTRODUCTION: Athletic groin pain is a common injury in sports involving repetitive twisting, kicking and turning movements (Quinn, 2010). It is particularly common in rugby union and its morbidity level means it is behind only fracture and joint reconstruction in terms of lost time from injury (Brooks *et al*., 2005). Inter limb asymmetry may be of relevance in the investigation of athletic groin pain as it has been suggested to be a risk factor for various other lower extremity injuries (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 dynamic sporting actions. To date however, no studies have investigated if kinematic and kinetic asymmetry is an important factor in athletic groin pain. Current methods of measuring inter limb asymmetry include isokinetic dynamometry, and counter movement jumping (CMJ) tasks. Whilst impulse and maximal power during CMJ tasks are more sensitive to asymmetries than isokinetic dynamometry (Menzel et al., 2013) it can be argued that a more comprehensive three dimensional (3D) assessment is required to analyse the multitude of sporting movements present in field based sports and gain insight into sport specific loading patterns. The aim of this study is to compare the levels of asymmetry present in rugby union players to that of athletic groin pain patients. It was hypothesised that the athletic groin pain group would demonstrate significantly greater asymmetries compared with the rugby union group.

METHODS: Recruited were 15 recreational field sports players diagnosed with chronic athletic groin pain who were patients at the Sports Surgery Clinic, Dublin, Ireland (mean ± *SD*; age, 25.6 ± 5.3 years; height, 181.4 ± 6.5 cm; mass, 82.7 ± 11.8 kg; time with groin pain, 50.8 ± 70.2 weeks). In addition, 15 elite international rugby union players, who were injury free at the time of testing, were also recruited (mean ± SD; age 20.4 ± 1.0 years; height 186.2 ± 7.6 cm; mass 98.4 ± 9.9 kg). 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 lateral hurdle hop and a running cut (75°) on an

artificial grass surface (polyethylene mono filament, Condor Grass, Holland). Eight infra red cameras (Vicon - Bonita B10, UK), synchronized with two force platforms (AMTI – BP400600, USA), were used to collect biomechanical 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 15 Hz. Standard inverse dynamics techniques calculated segmental and joint mechanics.
To examine asymmetries, hip and pelvis angles (in all three planes), hip moment (in all three planes) and the resultant hip power were analyzed using a continuous data analysis approach. To generate a mean curve for the three trials across each condition (left and right) all kinematic and kinetic waveforms were either manually landmark registered (using a dynamical time warping approach) or phase shift registered (Ramsay, 2006). The decision on the type of registration or landmark(s) was taken based on the characteristics of each individual's three trials. Subsequently, the normalized asymmetry (asym) was calculated using the registered left and right mean curves, for every time point t.

$$asym(t) = \frac{(\max[left(t) + \delta\ right(t) + \delta]) - (\min[left(t) + \delta\ right(t) + \delta])}{\max[left(t)\ right(t)] - \delta}$$

The registered left and right mean curves were also shifted by the factor δ (minimum value within both curves), to make all values within both curves positive. This was conducted to avoid a change in sign throughout the continuous waveform which would result in an erroneous normalized asymmetry curve. To examine the generated normalized asymmetry curves, an independent t-test (α = 0.05) was used to examine subject scores generated during an analysis of characterising phases (Richter *et al.*, 2013a). Analysis of Characterising Phases detects phases of variance (key phases) within a sample of curves, which are then used to generate subject scores within the magnitude domain of the data. Key phases are identified based on the information of VARIMAX rotation principal components that retains 99% of the data's variance (Richter *et al.*, 2013b). Data processing and statistical analysis was performed using MatLab (R2012a, MathWorks Inc., USA).

RESULTS: Differences in asymmetries were found in both the hurdle hop and running cut task. In the hurdle hop, hip flexion-extension plane moments displayed significantly greater asymmetry in the athletic groin pain group for most phases of the movement cycle. Hip abduction-adduction moments at the end of the movement (95-100 %) were also significantly more asymmetric in the athletic groin pain group, while greater asymmetries in pelvic tilt and obliquity range of motion (ROM) were found in the rugby union group throughout the hurdle hop landing (Table 1).

Table 1: Phases of movement displaying significant asymmetries between the athletic groin pain (AGP) and rugby union (RU) group in the hurdle hop

Variable	% key phase	P value	Asymmetry Summary
Hip internal-external ROM	57 – 66	0.039	RU > AGP
Hip flexion-extension moment	5-10	0.011	AGP > RU
	12-14	0.010	AGP > RU
	68-83	0.004	AGP > RU
	74-96	0.000	AGP > RU
	84-95	0.000	AGP > RU
Hip abduction-adduction moment	95-100	0.002	AGP > RU
Pelvis tilt ROM	1-24	0.002	RU > AGP
	7-34	0.006	RU > AGP
	92-100	0.047	RU > AGP
Pelvis obliquity ROM	1-33	0.009	RU > AGP
	11-59	0.012	RU > AGP
	39-74	0.017	RU > AGP
	66-81	0.021	RU > AGP

In the running cut task, particularly in the mid-to-late phases of the movement, hip abduction-adduction moments displayed greater asymmetries for the athletic groin pain group. The rugby union group demonstrated larger asymmetries at the start of the movement in hip abduction-adduction moment, hip internal-external rotation moment and net hip joint power (Table 2).

Table 2: Phases of movement displaying significant asymmetries between the athletic groin pain (AGP) and rugby union (RU) group in the running cut

Variable	% key phase	P value	Asymmetry Summary
Hip abduction-adduction moment	2-5	0.001	RU > AGP
	6-11	0.005	AGP > RU
	8-11	0.011	AGP > RU
	17-32	0.010	AGP > RU
	38-66	0.000	AGP > RU
	45-83	0.000	AGP > RU
	67-97	0.000	AGP > RU
	85-100	0.000	AGP > RU
Hip internal-external moment	3-9	0.004	RU > AGP
Net Hip joint power	1-6	0.001	RU > AGP

DISCUSSION: The aim of this study was to compare the levels of asymmetry present in rugby union players to that of athletic groin pain patients. In general, and as per our hypothesis, the athletic groin pain group displayed significantly greater inter limb asymmetries in hip ab/adduction and flexion/extension moments compared with the rugby union group. This is interesting given that asymmetrical loading at the hip may increase overload of the muscle, tendinous and bony structures of the anterior pelvis. The asymmetrical loading may reflect that either; (a) an inter-limb neuromuscular asymmetry may be a potential risk factor in developing athletic groin pain where one side is preferentially used in dynamic loading or (b) an inter-limb neuromuscular deficit becomes apparent as a result of the pain experienced by this population. Either way these results appear to indicate that inter-limb hip moment asymmetry may be of relevance in the examination of athletic groin pain.

Contrary to our hypothesis, the rugby union group displayed greater asymmetry in hip and pelvis range of motion measures. This apparent anomaly may potentially be explained, at least in part, by the high training level of the rugby union group (international level athletes). Previous research has also found elite level athletes to be asymmetrical in sports such as soccer (Rahnama *et al.,* 2005, McLean *et al.,* 1993 and Zahalka *et al.,* 2013) and rowing (Buckeridge *et al.,* 2014). The greater inter-limb asymmetry associated with elite populations may be caused by natural limb dominance during dynamic loading tasks and exacerbated by the larger volume of deliberate practice associate with elite populations (Smith, 2003). This may also explain why the rugby union group had greater hip moment and power asymmetry at the start of the cutting movement where eccentric limb loading is high.

A limitation of this study may be the comparison of the athletic groin pain group with elite athletes. It has been demonstrated that elite athletes display greater asymmetry in comparison to healthy males (Schiltz *et al.,* 2009). Despite this, the overall finding from this study is that the athletic groin pain group demonstrated greater magnitudes of asymmetry compared with the rugby union group. It is unknown if inter limb asymmetry is a risk factor for athletic groin pain. The results suggest however, that an aspect of rehabilitation for athletic groin pain should focus on reducing asymmetry. Whilst the rugby union group demonstrated greater asymmetry in some variables, it is important to note that players presenting leg asymmetries may not necessarily incur an injury. Furthermore, as noted by Hewitt *et al.,* (2012) players without inter limb asymmetries are certainly not exempt from injury. Future research should therefore ascertain if asymmetry has a causative relationship with athletic groin pain and if asymmetry in rugby union is a risk factor for injury.

CONCLUSION: Asymmetrical joint moments at the hip appear to be an important consideration in athletic groin pain populations. Whilst it is unknown if these asymmetries have a causative relationship with athletic groin pain, asymmetries are generally considered undesirable in the sports injury literature. As a result, an aspect of rehabilitation for athletic groin pain should focus on reducing asymmetric hip moments.

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