SHORT REPORT

Hip joint range of motion restriction precedes athletic chronic groin injury

Geoffrey M. Verrall\textsuperscript{a,*}, John P. Slavotinek\textsuperscript{b}, Peter G. Barnes\textsuperscript{a}, Adrian Esterman\textsuperscript{c}, Roger D. Oakeshott\textsuperscript{a}, Anthony J. Spriggins\textsuperscript{a}

\textsuperscript{a} SPORTSMED.SA Sports Medicine Clinic, Adelaide, Australia
\textsuperscript{b} Department of Medical Imaging, Flinders Medical Centre, Adelaide, Australia
\textsuperscript{c} School of Nursing, University of South Australia, Adelaide, Australia

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Hip joint range of motion; Hip stiffness; Chronic groin injury

Summary
Although a restricted hip range of motion has been previously associated with chronic groin injury the temporal course of this association remains unclear. Accordingly the purpose of this prospective cohort study was to report preliminary findings examining whether hip joint range of motion restriction is associated with subsequent onset of athletic chronic groin injury. End-range internal and external hip joint range of motion was determined in 29 elite Australian football players, without previous history of groin injury. The players were followed for two subsequent playing seasons for the development of chronic groin injury. Four athletes developed chronic groin injury defined as at least 6 weeks of groin pain and missing match playing time. In athletes that developed chronic groin injury a lower body weight \((p=0.02)\) and reduced total hip joint range of motion \((p=0.03)\) were found to be associated. This study suggests that hip stiffness is associated with later development of chronic groin injury and as such may be a risk factor for this condition. This work should be viewed as preliminary and caution is advised in applying the conclusion to clinical practice as the numbers in this study were small.

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Introduction

A restricted hip range of motion has been described in many of the diagnostic entities used to categorize sports-related chronic groin injury (CGI). A lower range of hip joint motion has been detected in athletes diagnosed with osteitis pubis,\textsuperscript{12} and in athletes with pubic bone stress injury.\textsuperscript{11} A lower range of motion in hip abduction has been associated with athletes diagnosed as having groin strain\textsuperscript{2} and adductor-related groin pain.\textsuperscript{7} However the temporal relationship between the development of hip stiffness and onset of CGI remains unclear as these studies were not performed prospectively\textsuperscript{11,12} or measurements of range of motion were not performed.\textsuperscript{2,7} Therefore it is not certain whether the presence of hip stiffness
precedes the development of CGI, or whether the presence of hip stiffness may develop with, or be subsequent to, the condition.6 Accordingly the aim of this study was to assess whether hip stiffness preceded the development of sports-related CGI in a cohort of elite Australian rules football (ARF) players.

**Methods**

**Subjects**

Ethical approval for the study was obtained from Flinders Medical Centre Committee for Clinical Investigation with written informed consent being provided by study participants. Twenty-nine male ARF players (average age 21.4 years, range 18—30 years) were voluntarily enrolled in the study from two professional clubs. Initially, a comprehensive history was taken from 89 ARF players by a single assessor using a direct interview technique. Of these a total of 60 football players were excluded on the basis that they were considered to have had either previous or current CGI (chronic groin pain present for at least 6 weeks). Age, height and weight were recorded for all subjects.

**Measurements**

Baseline internal and external hip joint range of motion testing was performed by a single examiner with the subject supine and with the hip and knee in 90° of flexion. An assistant was used to maintain the appropriate position of the hip and knee. The leg was rotated to maximum range of passive internal (IR) and external rotation (ER). Measurements were made using a standard goniometer. Dominant (kicking-leg) and non-dominant sides were examined sequentially.

Athletes were followed for two consecutive playing seasons (18 months from baseline measurements) for the development of CGI. Athletes were judged to have CGI if they had groin (adductor and/or lower abdominal and/or pubic bone region) pain for at least 6 weeks duration that caused them to miss at least one competitive match at any time during the subsequent two playing seasons. Each athlete was followed by either of two authors, who were team physicians for the two professional football clubs involved in this study, with no athlete being lost to follow-up during the study period. No intervention or specific instructions were given to any athlete involved in this study at any stage with respect to hip joint range of motion.

**Statistical analysis**

The range of hip joint internal and external rotation was assessed for any difference between the dominant and the non-dominant leg using paired samples t-tests. Age, height, weight, internal and external rotation (dominant and non-dominant) and total range of motion (sum of total internal and external rotation) were compared between those suffering from a subsequent CGI with those that did not using Student’s t-tests. Statistically significant variables underwent Poisson regression analysis to model the relationship between player characteristics and probability of injury.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Developed chronic groin injury</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No (£ = 25)</td>
<td>Yes (£ = 4)</td>
</tr>
<tr>
<td></td>
<td>Mean  S.E.M.</td>
<td>Mean  S.E.M.</td>
</tr>
<tr>
<td>Age</td>
<td>21.16  0.63</td>
<td>22.75  1.70</td>
</tr>
<tr>
<td>Height</td>
<td>177.36  6.82</td>
<td>175.50  2.33</td>
</tr>
<tr>
<td>Weight</td>
<td>84.92  1.99</td>
<td>72.50  3.28</td>
</tr>
<tr>
<td>Dominant IR</td>
<td>21.76  1.26</td>
<td>15.50  2.06</td>
</tr>
<tr>
<td>Non-dominant IR</td>
<td>20.78  1.09</td>
<td>15.50  1.32</td>
</tr>
<tr>
<td>Dominant ER</td>
<td>30.70  0.99</td>
<td>28.13  1.88</td>
</tr>
<tr>
<td>Non-dominant ER</td>
<td>29.94  1.04</td>
<td>24.00  1.35</td>
</tr>
<tr>
<td>Total ROM</td>
<td>103.18  3.31</td>
<td>83.13  4.28</td>
</tr>
</tbody>
</table>

All athletes had no prior history of chronic groin injury. IR: internal rotation; ER: external rotation; ROM: range of motion; S.E.M.: standard error of mean.

* Student’s t-test (two-sided tests, F-tests for equality of variances were undertaken for each t-test and in no case could we reject the null hypothesis of equal variances).
Table 2  Poisson regression analysis of statistically significant variables to model the relationship between player characteristics and probability of developing chronic groin injury

<table>
<thead>
<tr>
<th>Injury</th>
<th>IRR</th>
<th>Robust S.E.</th>
<th>z score</th>
<th>P value</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>0.92</td>
<td>0.026</td>
<td>−2.88</td>
<td>0.004</td>
<td>0.871 0.974</td>
</tr>
<tr>
<td>Total ROM</td>
<td>0.90</td>
<td>0.040</td>
<td>−2.14</td>
<td>0.033</td>
<td>0.834 0.992</td>
</tr>
</tbody>
</table>

ROM: range of motion; IRR: incident rate ratio; S.E.: standard error. IRR of 0.92 means that for each extra kilogram of weight there is an 8% reduction in injury rate, IRR of 0.90 means that for each increased degree in hip rotation there is a 10% reduction in injury rate.

Results

Four of the 29 athletes developed CGI by our definition (duration of groin pain for at least 6 weeks and missed match playing time). Paired t-tests demonstrated no significant difference between dominant and non-dominant legs with respect to internal and external rotation [dominant IR (mean 21, S.D. 6.4, range 10–40), non-dominant IR (20, 5.4, 12–35) p = 0.29], [dominant ER (30, 4.9, 17–40), non-dominant ER (29, 5.4, 19–40) p = 0.15].

Table 1 demonstrates that a lower body weight (p = 0.02) and a decreased total range of motion (p = 0.03) were risk factors for developing CGI. Regression analysis (Table 2) demonstrates that even after taking into account lower body weight a decreased total hip range of motion is still a risk factor for developing chronic groin injury.

Discussion

The principal finding in this study is that having a lower total hip joint range of motion was associated with subsequent development of CGI. As this study was performed prospectively using athletes that had no previous groin injury this gives support to the hypothesis that lower hip joint range of motion may precede the development of CGI. However as this finding is based on small numbers this hypothesis cannot be stated to have been conclusively proven.

It is difficult to account for the finding of decreased weight being associated with the subsequent development of CGI. It is possible that increased risk occurs in athletes who are lighter in response to being able to meet the extensive aerobic demands of Australian football. More research needs to be done looking in part at player position (midfield as opposed to key position), maximal oxygen uptake and aerobic power. However it was demonstrated that a decreased hip range of motion was associated with the subsequent development of the CGI even accounting for a decreased body weight.

As hip joint range of motion in athletes may change over a period of time, including with injury, it would have been useful to perform serial range of motion measurements for both the injured and uninjured groups. Failure to do this can be considered a weakness of this study. Also a single measurement was taken each time a joint was examined. It has been shown that a single measurement can be as reliable as the average of multiple measurements. However it is suggested that in joints with wide variation of movement, such as the hip joint, that multiple measures be performed, and as such this can be considered an error of methodology in this study. Finally no reliability assessment of measurements undertaken has been presented.

Additionally, other hip motions were not assessed; with the authors concentrating on the more simply measured internal and external range of motion. Also hip range of motion was only measured at 90° of hip flexion and it must be considered that most of the movement and load in Australian football occurs at a significantly less angle than 90°.

The earliest reference to an association between CGI and hip stiffness was in 1964. To our knowledge there are no precedents in the literature on this specific topic of a prospective nature, and as such our study can be considered to provide important preliminary information and a basis for further work. The potential clinical application of the findings is that maintaining or increasing hip joint range of motion may be useful in preventing CGI. Much more research needs to be undertaken before these assertions can be fully accepted, though it is unlikely that maintaining hip joint range of motion in athletes would have any foreseeable detrimental consequences.

There is very little in the scientific literature concerning on the exact determinants of hip internal and external range of motion and factors leading to reduction of these movements. Normal IR and ER range of hip motion is stated to be 30–40° and 40–60°, respectively. It is clear from this that all athletes in this study had a reduced hip joint range of motion on what is considered normal averaging 20° for IR and 30° for ER. A previous study has pos-
tulated that the athletic activity in ARF leads to a capsular response, akin to the shoulder joint and its response to throwing stressors,\textsuperscript{5} with a subsequent of restriction of hip joint range of motion.\textsuperscript{11} However objective evidence for this is lacking and further research is required and should consider why some athletes are affected whereas others are not.

Although we do not know the exact determinants of hip joint range of motion restriction in ARF we can develop a hypothesis why those athletes with hip stiffness maybe at increased risk of developing CGI. Previous studies have postulated that the mechanism of pain production in CGI can be due to a bony stress response.\textsuperscript{11} Pelvic biomechanical studies lend support to this view of increased stress to the central pubic bone area. These studies consider that during weight-bearing the superior pubic rami and the pubic symphysis act as a compression strut linking the femur to the posterior pelvic structures and spine,\textsuperscript{1} with the centers of rotation, or screw axes, being near the pubic symphysis.\textsuperscript{1} Thus the parasymphyseal bony area is the region of the anterior pelvis most vulnerable to the stressors of athletic activity. It is postulated that having a hip joint range of motion restriction results in greater stress across the superior pubic ramus and pubic symphysis.\textsuperscript{11} This in turn may lead to increased force/stress in this vulnerable area, particularly distraction and/or tension, with increased likelihood of the athlete having CGI consistent with a pubic bone stress injury.\textsuperscript{11}

**Conclusions**

This preliminary study demonstrates that having a hip joint range of motion restriction precedes the development of chronic groin injury and may be a risk factor for this condition. This finding may represent a new avenue of investigation of this troublesome and common athletic condition. We acknowledge that our study group numbers were limited and further research is needed.

**Conflict of interest**

No benefits or funds were received in support of this study. This study was presented at the Sports Medicine Australia conference in Canberra, 2003.

**References**