The Association of Hip Strength and Range of Motion with Hip and Groin Pain in Collegiate Ice Hockey Players

Original Research

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Abstract

Introduction: Hip and groin pain is common in male ice hockey players. The relationship between physical examination findings and hip and groin pain in collegiate male hockey players is not well established. The purpose of this study was to explore associations between hip strength and hip range of motion (ROM) and hip and groin pain in male collegiate ice hockey players.

Methods: This was a cross-sectional study of 59 male ice hockey players. The Sport subscale of the Copenhagen Hip and Groin Outcome Score (HAGOS) were collected to identify those with hip and groin pain. Measurements of hip ROM and strength were obtained at the beginning of the season. Between group comparisons were made and logistic regression was used to determine the strength of the association.

Results: Compared to those without, male ice hockey players with hip and groin pain (n=17) had a lower amount of hip internal rotation ROM (-6.21; 95% CI 2.29, 10.14; $p<0.01$) and a lower ratio of hip adductor to abductor strength (-0.16; 95% CI -0.27, -0.05; $p<0.01$). These two variables explained 37% of the difference between groups ($R2=0.37$; $p<0.01$). There was no significant difference in hip external rotation ROM between groups.

Conclusions: Hip internal rotation ROM and the ratio of hip adductor to abductor strength were lower in male collegiate ice hockey players with hip and groin pain compared to those without. These findings may help inform secondary prevention and rehabilitation strategies in this population.

Key Words: hip adductor, injury screening, injury prevention

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Introduction

Hip and groin pain is a common issue in competitive college athletes, and the prevalence of hip and groin pain varies substantially between different sports [1]. Ice hockey players are much more likely to suffer from hip and groin pain compared to athletes in other sports, and this risk may be greater in males compared to females [1,2]. Dalton and colleagues found men's collegiate ice hockey players to be 8.67 times more likely to have prolonged disability from hip and groin injuries than women's ice hockey players [2]. There is also limited evidence that the prevalence of hip and groin pain increases with higher levels of competition: collegiate ice hockey players had injury rates 1.88 times higher than high school hockey players [3]. The trend for higher injury rates at higher levels of competition is seen elsewhere in ice hockey, but different methodological approaches make comparisons difficult [4]. As the prevalence of hip and

groin pain is influenced by the sex, type of sport, and level of competition, it is essential to highlight specific injury profiles faced by individual athletes. In addition to the short-term suffering and loss of function, competitive male ice hockey players with hip and groin pain are at higher risk for prolonged disability, surgery, and lifelong hip complications, including up to a three times higher risk of hip osteoarthritis [1,5].

The short- and long-term impact of hip and groin pain in male ice hockey players has prompted strategies for primary prevention and early identification. An evaluation conducted by a healthcare professional has historically guided such practice. However, such practices may underestimate the prevalence of injury and risk missing athletes who are suffering from the earlier stages of a hip and groin injury [6]. Athletes may not seek medical evaluations for several reasons, including, but not limited to, lack of time, limited resources/personnel, or fear of missing playing time [7,8]. Athletes with mild symptoms are more likely to progress to missing playing time and developing more severe symptoms compared to athletes with no symptoms [9]. In one study of semi-professional soccer players, athletes who had minor or non-time-loss complaints were up to 6.9 times more likely to suffer from a time-loss injury later on [9]. Worner and colleagues found that the Copenhagen Hip and Groin Outcome Score (HAGOS) questionnaire, which can be easily administered by training or coaching staff, can be helpful in detecting the presence of symptoms and may be more sensitive due to the ease of access [6].

Physical examinations are often employed for identifying athletes suspected of being at risk for or having a hip and groin injury. In addition to aiding in the identification of individuals who are either symptomatic or at risk for becoming so, obtaining measurements of strength and range of motion (ROM) at the hip are often utilized to guide prescription for primary and secondary prevention of hip and groin pain [10-12]. Athletes with hip and groin pain are more likely to present with weakness in the hip adductor muscles. However, this appears to vary based on both the population studied, method of strength assessment, and operational definition of hip and groin pain [13-15]. For example, male and female semi-professional soccer players and professional male ice hockey players with hip and groin pain have been found to have weaker hip adductor muscles than healthy controls. However, this relationship was not found in male field hockey players [16-18]. There is also inconsistent evidence that athletes with hip and groin pain may present with limited ROM of the hip. Gaelic football players with chronic groin pain demonstrated reduced hip abduction, internal rotation, and external rotation ROM compared to healthy controls [19]. Professional male soccer players with hip and groin symptoms demonstrate 5.0 degrees less hip internal rotation ROM but no significant difference in hip abduction ROM compared to controls [20]. To the authors' knowledge, no studies exist assessing for an association between hip ROM and hip and groin pain in male collegiate ice hockey players.

Research on physical examination findings for athletes with hip and groin pain varies across sports and competition levels. There is limited research regarding hip strength in ice hockey, only at the professional level, and no available research on male ice hockey players who compete at the collegiate level. Further, the physical examination findings for ice hockey players with hip and groin pain who do not have a time-loss injury are not known, which could inform secondary prevention. Therefore, the purpose of this study was to explore associations between hip strength and hip ROM in male collegiate ice hockey players with hip and groin pain without a time-loss injury and healthy controls. The hypothesis was that those with pain will have reduced hip strength and hip ROM compared to those without.

Scientific Methods

Participants

This was a cross-sectional cohort study that included 59 male collegiate ice hockey players at two different universities at the beginning of the 2022-2023 competitive season. The sample size for this study was based on a previous study which used a similar sample size for a comparable research question [15]. All subjects in this study first provided written informed consent prior to enrollment. Inclusion criteria included being a current or prospective member of a men's club collegiate ice hockey team, and currently a full participant in team events. Exclusion criteria included any major lower extremity injury greatly limiting participation within the prior 6 months, or hip and groin surgery within the prior 12 months. Additional information collected included age, playing experience, shooting handedness, and primary position played. This study protocol was approved by the Western Michigan University Institutional Review Board (#210413).

Protocol

Participating subjects first completed the HAGOS Sport subscale. This subscale has previously been deemed useful in isolation for identifying hip and groin problems in competitive athletes [21-23]. This was administered through a

Qualtrics (Qualtrics, Provo, UT) online digital survey. A subject was classified as having hip and groin pain if their adjusted HAGOS Sport subscale score was lower than 90. Prior research suggests this approximates a cut-off value that distinguishes competitive athletes with hip and groin pain to healthy controls in athletes [23,24]. This method was used to better assess the burden of hip and groin pain as well as to avoid underestimating hip and groin pain [6,7].

At the very beginning of the competitive season and prior to the first organized practice, all participating subjects were subjected to a brief physical exam. This was conducted by a single board-certified sports physical therapist with greater than a decade of experience. The physical therapist was not aware of the HAGOS Sport subscale results of individual subjects at the time of testing. To assess hip internal and external rotation ROM, the subject was supine, and the examiner flexed and stabilized the subjects' hip at 90 degrees of flexion. The examiner then passively rotated the lower leg into first external rotation and then internal rotation (Figure 1A and 1B). To standardize the measurement, the motion was halted at the first instance that passive resistance was perceived by the examiner regardless of symptoms. A standard goniometer was used to quantify each of the ROM measurements, with the stationary arm aligned parallel to the trunk and the moving arm aligned to the tibia. This method of assessing hip ROM was selected because it has previously been deemed as reliable and is commonly used for hip ROM assessment in the athletic population [25]. Isometric hip strength was assessed in supine with the hip in a neutral (0 degrees of flexion) position. The examiner used a hand-held dynamometer (Microfet-2, Hoggan-Scientific, Salt Lake City, UT) placed just superior to the medial and lateral malleoli to assess isometric hip adductor and hip abductor strength (Figure 1C and 1D). The subject was

Figure 1. Assessment of hip range of motion and isometric strength. 1A: hip external rotation; 1B: hip internal rotation; 1C: hip adductor strength; 1D: hip abductor strength.

instructed to gradually build up to a maximal force output into the dynamometer over a span of three seconds. This has previously been found to be a valid and reliable method of assessing hip strength [26]. Prior to the beginning of the study, an intra-rater reliability study was conducted with all of these measurements with convenience subjects. This demonstrated an ICC of 0.664 to 0.992, indicated moderate to excellent reliability. To account for differences in sizes and statures between players, the ratio of hip adductor to abductor strength was calculated for comparison of groups [18].

Statistical Analysis

Statistical analysis was performed using R 4.3.0 (R Core Team, 2023). Descriptive statistics were calculated, and normality was assessed using the Shapiro-Wilk test. Independent samples t-tests with Bonferroni corrections to control for family-wise error rate were used to compare subjects with hip and groin pain to those without for the ratio of hip adductor to abductor strength and hip external rotation ROM. Hip internal rotation ROM yielded a significant result for the Shapiro-Wilk test, therefore a Mann Whitney U test was used to compare groups. A logistic regression model was used to determine the effect size for all significant variables. Statistical significance was set at $p \leq 0.05$ a priori.

Results

Seventeen (17/59) subjects met the classification for having hip and groin pain. The pain-free group was 19.4 ± 1.2 years old and the painful group was 20.0 ± 1.3 years old. Pain-free and painful subjects had 1.3 ± 1.2 and 1.6 ± 1.4 years of experience, respectively, playing collegiate ice hockey. The pain-free group consisted of 15 defensemen, 21 forwards, and six goaltenders, whereas the painful group consisted of three defensemen, 12 forwards, and two goaltenders. Thirty-five percent (15/42) of the pain-free subjects were left-handed and 24% (4/17) of the painful subjects were left-handed. Differences between groups for HAGOS Sport, hip internal rotation ROM, hip external rotation ROM, and the ratio of hip adductor to abductor strength are displayed in Table 1. Tjur's R^2 from the logistic regression model of the ratio of hip adductor to abductor strength and hip internal rotation was 0.37 ($p<0.01$).

Table 1. Differences in clinical measures between subjects with non-painful and painful hips.

	Non-Painful (n = 42)	Painful (n = 17)	Difference (95% CI)	P
HAGOS Sport	97.92 ± 2.98	73.34 ± 11.96	-24.58 (-30.77, -18.37)	<0.01
Hip Internal Rotation ROM (degrees)	25.21 ± 6.08	19.00 ± 6.86	-6.21 (-10.14, -2.29)	<0.01
Hip External Rotation ROM (degrees)	32.21 ± 6.91	32.06 ± 8.52	-0.15 (-4.63, 4.94)	0.95
Ratio of Hip Adductor to Abductor Strength	1.11 ± 0.23	0.95 ± 0.17	-0.16 (-0.27, -0.05)	<0.01

Note: Data are Means ± SD except difference is expressed with a 95% confidence interval (CI). HAGOS = Hip and Groin Outcome Score; ROM = range of motion.

Discussion

This study aimed to assess for associations in hip strength and hip ROM between male collegiate ice hockey players with and without hip and groin pain. Those with pain demonstrated a 6.21 degree reduction in hip internal rotation ROM and a reduction in the ratio of hip adductor to abductor strength of 0.16 compared to those without pain. These two findings alone accounted for 37% of the difference between groups in this study, implicating a significant statistical effect size. The findings of this research should aid in informing healthcare providers and training staff about the physical presentation of male collegiate ice hockey players with hip and groin pain.

The finding of reduced hip internal rotation ROM in our study is particularly interesting, as prior research investigating ROM differences between athletes with and without hip and groin pain has produced variable results. This may be due to unique biomechanical demands in ice hockey, which require forceful movements of the hip from a flexed and internally rotated position [27]. This may result in sensitized or painful structures specific to this position. The reduction in ROM at the hip found in this study may result from muscle guarding against a painful position. Conversely, while the hip is also subjected to large amounts of hip external rotation ROM during ice hockey, this occurs at or near full extension [27]. Therefore, sensitized or painful structures are less likely to be stressed in hip external rotation measured in the traditional sense of stabilizing in a position of hip flexion, such as in this study. Assessment of hip external rotation ROM in an extended position may yield different results, and further research is warranted to assess this [28]. Further, the clinical relevance of the differences found in this study (6.21 degrees) is unclear.

An alternative explanation for the reduction in hip internal rotation ROM seen in the symptomatic subjects in this study is related to hip joint morphology. The presence of a cam morphology of the hip joint, which describes a bony overgrowth of the femoral neck, is correlated with a reduction in hip internal rotation ROM [29]. While cam morphologies are common in ice hockey players, larger cam morphologies, which may further reduce hip internal rotation ROM, are correlated with hip and groin pain [29]. The structural anatomy of the subjects in this study is not known. However, the results of a reduced hip internal rotation ROM in conjunction with reported hip and groin symptoms may warrant a referral to a health care provider.

The findings of this study regarding a reduction in the ratio of hip adductor to abductor strength in those with hip and groin pain are consistent with prior research on professional hockey players and other athletes. A likely explanation is that the musculotendinous structures of the hip adductors are not only highly stressed in ice hockey but are also frequently implicated in groin pathology [30]. Further, emerging evidence suggests there may be spinal or cortical muscle inhibition of hip muscles with the presence of pain, which may have contributed to the reduction in strength seen in this study [31]. However, as hip adductor strength was assessed relative to hip abductor strength, if this were true, this suggests the hip adductor muscles are disproportionately affected by inhibitory pathways. This would be analogous to the effects of knee pain disproportionately affecting the quadriceps compared to other muscles of the knee [32]. This has significant implications for injury profiling and rehabilitation, suggesting that the hip adductor muscles may warrant targeted attention in both processes. Further research identifying the role different muscles and reflexive neuromuscular inhibitory pathways play in different hip and groin pathologies will be of value. Additionally, future research clarifying the role of assessing range of motion and strength to identify those at risk for future injury will be of benefit for practitioners working with these athletes. While this study identified relationships at one point in time, it is not known how these measurements may predict future injury risk [28].

This study carries notable considerations. The use of standardized, reliable, and valid measures of hip ROM and isometric hip strength strengthens this study. However, a complete assessment of lower body ROM and strength was not performed. It is unknown if there were any differences between groups in the strength or ROM of other directions. However, as hip internal rotation ROM and the ratio to hip adductor to abductor strength alone explained 37% of the difference between groups, this may provide a valuable initial screening tool for practitioners or training staff with limited time. Further, as this study aimed only to identify associations, no casual relationships should be inferred from the results of this study. Finally, the subjects in this study were all male collegiate ice hockey players, and while the homogeneity of the subjects is a strength in methodology, this limits generalization to other populations, such as female players or males at different levels of competition.

Conclusions

Male collegiate ice hockey players with hip and groin pain presented with a reduced ratio of hip adductor to abductor strength and reduced hip internal rotation ROM in this study. The results of this study may aid in early identification and rehabilitation of athletes with hip and groin pain. The findings of this study may also inform preventative care for this population.

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