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Human Kinetics
CRITICALLY APPRAISED TOPIC

Measuring the Hip Adductor to Abductor Strength Ratio in Ice Hockey and Soccer Players: A Critically Appraised Topic

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Clinical Scenario: Ice hockey and soccer are both dynamic sports that involve continuous, unpredictable play. These athletes consistently demonstrate higher rates of groin strains compared with other contact sports. Measuring the hip adductor/abductor ratio has the potential to expose at-risk players, reduce injury rates, and preserve groin health in players with chronic strains. ***Focused Clinical Question:*** What is the clinical utility of measuring the hip adductor/abductor ratio for preseason and in-season ice hockey and soccer players? ***Summary of Key Findings:*** Three studies, all of which were prospective cohort designs, were included. One study involved assessing preseason strength and flexibility as a risk factor for adductor strains in professional ice hockey players. Another study performed with the same professional hockey team used preseason hip adductor/abductor strength ratios to screen for those players who would benefit from a strengthening intervention aimed at reducing the incidence of adductor strains. The final study, which was performed in elite U17 soccer players, assessed the effectiveness of monthly in-season strength monitoring as a guide to trigger in-season interventions to decrease injury incidence. ***Clinical Bottom Line:*** Measuring the hip adductor/abductor strength ratio in hockey and soccer players can be a beneficial preseason and in-season tool to predict future groin strain risk and screen for athletes who might benefit from a strengthening intervention. ***Strength of Recommendation:*** Level 3 evidence exists to support monitoring the hip adductor/abductor strength ratio to assess and reduce the risk of adductor strains in ice hockey and soccer players.

Keywords: physical therapy, physiology, rehabilitation, sport medicine, testing and measurement

Clinical Scenario

Ice hockey and soccer consistently demonstrate higher rates of groin strains compared with other contact sports. Orchard,[1] in a recent systematic review, concluded that when comparing 15 different college sports, men and women's ice hockey had the highest rates of groin strains (13.1% and 12% of all practice injuries, respectively). Men's soccer had the second highest injury rates (7.8% of all practice injuries). In elite-level Swedish ice hockey players, Lorentzon et al[2] reported that adductor strains accounted for 10% of all injuries. In the National Hockey League (NHL), Epstein et al[3] reported that out of 1441 players from 2006 to 2010, 890 sustained a hip or groin injury. Perhaps the most well understood risk factor for groin strains is reduced hip adductor strength. This includes isolated adductor strength and adductor relative to abductor strength (adductor/abductor ratio).[4,5] Tyler et al[5] reported that NHL players who sustained an adductor strain had on average 18% lower preseason isolated adductor strength values compared with uninjured players. In addition, the injured players had significantly lower adductor/abductor strength ratios (78% vs 95%, respectively). Several studies[6–7] have provided evidence to support measuring the hip adductor/abductor strength ratio throughout the course of a season to identify players who are at risk for sustaining a groin strain.

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Focused Clinical Question

What is the clinical utility of measuring the hip adductor/abductor strength ratio for preseason and in-season ice hockey and soccer players?

Summary of Search, "Best Evidence" Appraised, and Key Findings

- The literature was searched for any articles that reported measuring the adductor/abductor strength ratio in preseason or in-season hockey and soccer players. Three prospective cohort studies[6–7] were identified.
- Tyler et al[5] performed preseason screening examinations on NHL players, which included hip flexibility, hip strength, and injury history. The authors reported that the hip adductor/abductor strength ratio was the best predictor of a future adductor strain. Relative risk for an adductor strain was 17:1 based on a hip adductor to abductor ratio less than 80%.
- Building on their previous study, Tyler et al[6] once again performed preseason screening examinations on NHL players. Players with adductor/abductor strength ratios <80% participated in a 6-week (3×/wk) preseason exercise program focusing on adductor strengthening (concentric, eccentric, and "functional"). There was no formal control group. Players were followed for 2 consecutive seasons. The authors reported a statistically significant reduction in incidence compared with the previous 2 years with the same team (3 documented adductor strains vs 11, respectively).

- Wollin et al[7] followed elite male Australian U17 soccer players throughout the course of 2 seasons. Strength measurements, which were recorded during the preseason and monthly during the season, included eccentric adductor strength and the adductor/abductor strength ratio. Alerts were triggered if players demonstrated a 15% drop in unilateral eccentric hip adductor strength or an adductor/abduction strength ratio <90%. Triggered players were then retested later that afternoon. If strength measures were not restored, this resulted in time loss from play and remedial-strengthening interventions until their measures were restored. Adductor/abductor strength ratios were lowest at preseason testing and increased significantly by month 2. The authors proposed that soccer-specific strength can deteriorate after an off-season break and that regular monitoring of strength can help determine a player's readiness to loading.

Clinical Bottom Line

Level 3 evidence exists to support measuring the hip adductor/abductor strength ratio in ice hockey and soccer players to screen for risk of sustaining an adductor strain. Level 3 evidence exists to support monitoring and correcting this ratio in-season for soccer players to reduce injury risk and time loss. Level 3 evidence exists to support the use of a preseason or in-season adductor strengthening intervention to reduce risk of injury in ice hockey and soccer players.

Strength of Recommendation

There is moderate evidence to suggest that measuring the hip adductor/abductor strength ratio in hockey and soccer players can be a beneficial preseason and in-season tool to predict future groin strain risk and screen for athletes who might benefit from a strengthening intervention. This may help ultimately preserve groin health and reduce time loss due to injury. Although the studies reviewed in this critically appraised topic highlight the benefits of measuring and monitoring the hip adductor/abductor strength ratio, each study has limitations.

Search Strategy

Terms Used to Guide Search Strategy

- **P**atient Group: ice hockey and soccer players
- **I**ntervention: measuring the hip adductor/abductor strength ratio
- **C**omparison: none
- **O**utcome: groin strain incidence and/or strength improvement

Sources of Evidence and Databases Searched

- PubMed
- Cochrane
- Google Scholar
- Physiotherapy Evidence Database (PEDro)

Inclusion and Exclusion Criteria

Inclusion Criteria

- Preseason and/or in-season hockey and soccer players (all levels)
- Assessment of hip adductor/abductor strength ratio
- Documentation of groin health (via injury records or outcome measures)
- Available in English

Exclusion Criteria

- Studies that did not follow athletes over the course of at least 1 season

Results of Search

Three relevant studies[5–7] were found and are represented in Table 1. All studies were cohort designs.

Best Evidence

The selected studies were the best match in accordance with the inclusion and exclusion criteria listed above. This represents the highest available evidence that measured hip adductor/abductor strength ratio and collected injury data throughout the course of an entire ice hockey or soccer season. Summaries of the selected study characteristics are presented in Table 2.

Implications for Practice, Education, and Future Research

Ice hockey and soccer are both dynamic sports that involve repetitive directional changes, body contact, kicking, and striding in an unpredictable environment. This increases the demand on the hips and adductor musculature to control for high acceleration and deceleration forces.[8] Understanding the physical requirements of each sport can help one appreciate the importance of maintaining a high adductor to abductor strength ratio.

In a recent prospective study involving 110 athletes in various sports, Serner et al[9] found that kicking was the most common mechanism for acute groin injuries in soccer. The adductor longus was the most frequently injured muscle, and 81% of injuries involved the kicking leg. Charnock et al[10] performed motion analysis on Division 1 college male soccer players during maximal effort soccer kicking. The authors found that the adductor longus is most susceptible to injury at the end of the windup phase when the kicking leg is in a position of maximum hip extension. At this position, the adductor longus demonstrated both maximum eccentric activation and maximum rate of lengthening. It also represented a transition point from eccentric to concentric activation during initiation of hip flexion. The authors concluded that risk of an adductor longus injury increases with an increase in peak hip-extension angle.[10]

Table 1 Summary of Selected Study Designs

Level of evidence	Study design	Year published	Reference
2b	Prospective cohort	2001	Tyler et al[5]
2b	Prospective cohort, risk factor prevention	2002	Tyler et al[6]
2b	Longitudinal cohort	2018	Wollin et al[7]

Table 2 Characteristics of Selected Studies

	Tyler et al[5]	Tyler et al[6]	Wollin et al[7]
Study design	Prospective cohort	Prospective, risk factor prevention	Longitudinal cohort study
Participants	N = 47, National Hockey League players under contract with 1 team for 2 consecutive seasons (1997–1998 and 1998–1999). Only 17/47 players were followed through the entirety of the 2 seasons.	N = 58, National Hockey League players under contract with 1 team for 2 consecutive seasons (1999–2000 and 2001–2002). Only 12/58 players were followed through the entirety of the 2 seasons.	N = 27, male under 17 Australian soccer players selected from part-time training centers to commence full-time training at the football association's center of excellence program.
Intervention investigated	Preseason screening examination: injury history, hip strength, and flexibility measurements. Strength measurements included hip flexion, abduction, and adduction strength via handheld dynamometry. The average of 2 maximum efforts was used. Adductor flexibility was measured in supine with a goniometer. Hip flexor flexibility was measured by the Thomas test, and a goniometer quantifying the degrees of hip flexion above or below horizontal.	Preseason screening examination: injury history, hip strength, and flexibility measurements. Strength measurements included hip flexion, abduction, and adduction strength measurements via handheld dynamometry (force required to break muscle contraction was recorded via Newton). The average of 2 maximum efforts was used. Adductor flexibility was measured in supine with a goniometer. Hip flexor flexibility was measured by the Thomas test, and a goniometer quantifying the degrees of hip flexion above or below horizontal. Players who had an adductor to abductor strength ratio <80% participated in a 6-wk (3×/wk) preseason exercise program focused on adductor muscle (concentric, eccentric, and functional) strengthening.	Pretraining screening: preseason testing of hip adductor strength, adductor/abductor strength ratio, the HAGOS, anthropometric data, and a record of past injuries and training history. Monthly in-season retesting of all the above criteria was performed across 22 time points (on the morning of the first regular training day back after a rest day roughly 40 h post-match). Each of the above criteria represented a possible alert that a player could have triggered during any of the 22 retest time points. Unilateral adductor and abductor strength was tested in supine. A break test was used to replicate an eccentric component. Strength was recorded with a handheld dynamometer. *An alert was defined as any decrease in adductor strength measurement by >15% or a hip adductor/abductor ratio <0.90.* Players completed electronic HAGOS scores for each subscale at each time point. *An alert was defined as >75/100 in any subscale.* Players identified with alerts proceeded through an individualized, multimodal management approach consisting of manual therapy and hip strength and activation exercises until strength reductions was restored.
Outcome measure(s)	No specific outcome measures were used. Primary outcomes were *injuries* over the course 2 seasons (defined as any event that kept a player out of a practice or game or required attention of the team physician). Adductor strains were graded as I (pain, but minimal loss of strength and minimal restriction of range of motion), II (tissue damage that compromised the strength of the muscle but did not include complete loss of muscle strength and function), and III (complete disruption of the muscle tendon unit and complete loss of function of the muscle).	No specific outcome measures were used. Primary outcomes were *injuries* over the course 2 seasons (defined as any event that kept a player out of a practice or game or required attention of the team physician). Adductor strains were graded as I (pain, but minimal loss of strength and minimal restriction of range of motion), II (tissue damage that compromised the strength of the muscle but did not include complete loss of muscle strength and function), and III (complete disruption of the muscle tendon unit and complete loss of function of the muscle).	HAGOS, including all 6 subscales (pain, symptoms, activities of daily living, sport and recreational activities, participation in physical activity, and quality of living). Each subscale is scored from 0 to 100 with a higher score indicating better hip and groin health. Time loss was calculated for detected injuries and subclinical presentations requiring load management. Time loss was defined as minimal (1–3 d), moderate (8–28 d), and severe (>28 d).

(continued)

Table 2 *(continued)*

	Tyler et al[5]	Tyler et al[6]	Wollin et al[7]
Results	141 injuries were sustained (17 per 1000 player exposures). There were 11 documented adductor strains in 8 players (3.2 strains per 1000 player exposures). All occurred during games. There were 9 grade I and 2 grade II strains. Players who sustained an adductor strain had a mean 18% lower preseason adductor strength measurement compared with uninjured players. Within injured players, there was no difference in hip adduction strength between the injured and uninjured limb. Uninjured players had a significantly higher average preseason hip adductor to abductor strength ratio compared with injured players (95% vs 78%, respectively). Within players who sustained an injury, the injured limb had a significantly lower hip adductor to abductor strength ratio compared with their uninjured limb (70% and 86%, respectively). There were no significant differences with regard to flexibility in players who did and did not sustain adductor or groin injuries.	140 injuries were sustained (13.6 per 1000 player exposures). In total, 33/58 players had preseason adductor to abductor ratios less than 80%. All of them participated in the preseason adductor strengthening program. However, only 12/33 players were followed up over the entire course of both seasons. Of the 12 players followed over both seasons, there were only 3 documented adductor strains in 3 different players (0.71 strains per 1000 player exposures). The study cited this as a significant result ($P < .05$). All occurred during games and were grade I strains. All 3 players were in the intervention group; however, one of the players sustained his injury in the preseason after only completing 5 sessions of the intervention.	105 total alerts were detected in 19 players (70% of the cohort). 40% of all alerts were strength related (adductor and/or adductor/abductor ratio), whereas 60% were HAGOS related (nearly half of these were discovered at preseason). 52% of players had a history of a time-loss groin injury. Strength-related alerts resulted in 34 total time-loss days (11 occurrences in 8 players). 82% of occurrences were defined as minimal (1–3 d). In-season HAGOS-related alerts resulted in 31 total time-loss days (4 total occurrences). 75% of occurrences were defined as minimal (1–3 d). By contrast, preseason HAGOS-related alerts resulted in 85 total time-loss days (6 total occurrences). All occurrences were defined as moderate (8–28 d). Both hip adductor strength and the adductor/abductor strength ratio changed significantly during the seasons and demonstrated significant improvement by month 2 when compared with baseline. There was no correlation between HAGOS scores and strength scores.
Level of evidence	2b	2b	2b
Quality assessment (Newcastle-Ottawa Quality Assessment Form for Cohort Studies)	5/9 stars (fair quality)	5/9 stars (fair quality)	6/9 stars (good quality)
Conclusion	In professional ice hockey players, the hip adductor/abductor strength ratio was the best predictor of a future adductor strain. Relative risk for an adductor strain was 17:1 based on a ratio <80%.	In professional ice hockey players that were identified to be at risk for sustaining an adductor strain (hip adductor/abductor ratio <80%), a 6-wk preseason strengthening program can be effective in lowering the incidence of adductor strains throughout the course of 2 competitive seasons.	In U17 soccer players, preseason and in-season monitoring helps identify groin problems early to trigger a cascade of interventions aimed at restoring individual player strength, health, and function. Days lost in-season due to the indicated preventative measures and rehabilitation were significantly less than in preseason. This design may also help limit chronic groin health deterioration and future time-loss events.

Abbreviation: HAGOS, Hip and Groin Outcome Score.

In ice hockey, normal forward striding consists of large propulsive forces produced by the hip extensor and abductor musculature. The stride leg pushes into a position of hip extension, abduction, external rotation, knee extension, and ankle plantar flexion. The adductors act as antagonists to decelerate and control for the explosive abductors. This requires an adequate balance of strength between the adductors and abductors to prevent excessive stride length and risk of adductor strains. At the end of initial stride propulsion, the adductors and hip flexors then quickly transition from working eccentrically to concentrically to reposition the skate under the body for stride turnover. This period of time, immediately after the skate pushes off until it is brought forward to push off again, is defined as the recovery phase.[11] The recovery phase is especially important in ice hockey. Faster skaters spend less time in this phase and have faster stride turnover, leading to increases in overall skating velocity.[11] This highlights the need for both eccentric and concentric adductor strength in controlling stride length, improving stride turnover, and reducing risk of injury.

Based on these repetitive mechanisms, it is not surprising that the incidence of adductor strains is higher among ice hockey and soccer athletes compared with those in other contact sports.[1] These athletes must build and maintain adequate hip adductor strength throughout the course of a season to reduce their risk of injury. So how should clinicians utilize the hip adductor/abductor strength ratio? In addition, what are the implications of monitoring this ratio throughout the course of a season?

When working with ice hockey and soccer players, clinicians should measure the adductor/abductor ratio as a preseason screen to help identify those who are at higher risk for sustaining adductor strains. Tyler et al,[5] in the first article reviewed in this critically appraised topic, demonstrated the importance of hip adductor strength as a predictor of future adductor strain. Injury risk was 1 per 3.75 hips that tested an adductor/abductor ratio less than 80%, with a relative risk for sustaining an adductor strain of 17:1. With regard to timing of assessment, the preseason appears to have higher vulnerability to injury. Data exist showing that adductor strains were 20× more frequent during training camp compared with regular training, suggesting that training errors such as preseason deconditioned states and lower levels of sport-specific training play a role[4,8]

The hip adductor/abductor strength ratio should also be used to help clinicians decide which athletes should participate in a strengthening intervention focused on reducing risk of adductor strains. In the second study reviewed in this critically appraised topic, Tyler et al[6] concluded that the preseason hip strengthening in professional ice hockey players who had adductor/abductor strength ratios less than 80% lowered the incidence of adductor strains compared with the previous season. Although this study did demonstrate an effective and statistically significant intervention, it had a few key limitations. Of the 33 players who were identified to have adductor/abductor strength ratios less than 80%, 25 were either cut from the team or had dropped out, subsequently excluding them from the study and any true determination if injury had occurred. In addition, of the players who did sustain a groin strain, all had participated to some extent in the preseason strengthening intervention. Compliance was not reported for these players. Finally, the authors did not retest strength ratios in any players at the completion of the strengthening intervention or throughout the course of the season, which makes it unclear if players had truly restored their ratios above 80% prior to any reinjury.

In addition to measuring the adductor/abductor strength ratio in the preseason, clinicians should utilize continuous monitoring throughout the course of a season. Wollin et al,[7] in the third article reviewed in this critically appraised topic, proposed the method of early detection and continuous monthly monitoring of strength ratios as a means of secondary prevention. The authors reported significant improvements in strength ratios from preseason, with the largest increases shown at month 2. This method allowed for players to be flagged and appropriately addressed routinely throughout the entire season. The authors concluded that this method could provide a promising alternative and/or complement to primary prevention efforts in reducing overall time loss due to injury. Considering that athletes with a history of a groin strain are 2.4× more likely to have recurrence,[4] frequent monitoring may be crucial in preserving long-term groin health.

Groins strains cannot absolutely be prevented, but proper screening and applied strengthening interventions can help significantly reduce an athlete's risk of injury. There is good clinical utility for measuring the hip adductor/abductor strength ratio both at preseason and continuously throughout the course of a season. The ratio should be used as a screen for injury risk and as a funnel for those who would benefit from active strengthening interventions in hopes of reducing overall incidence.

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