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Characterising groin pain in rink hockey: Function and five-second squeeze in Spanish players

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ABSTRACT

Objectives: To assess the relationship between history of past season groin pain and current pain during the five-second squeeze test (5SST) with groin function and adductor strength in rink hockey players.
Design: Cross-sectional.
Setting: First (Ok Liga), Second (Plata) and third division (Bronce) clubs. Participants: Sixty-eight female and 183 male hockey players.
Main outcome measures: Seasonal prevalence of groin pain (time/non-time-loss). Adductor strength and pain during the 5SST. Function was evaluated with the Hip and Groin Outcome Score (HAGOS).
Results: Seasonal time-loss groin pain prevalence was 21%. Male players had 3.5 higher odds of having had an episode of time-loss groin pain during the previous season compared to female players. The adductor relative strength was no different between players with and without previous season groin injury ($p = 0.53$-0.55), while the HAGOS results differed between groups, with past season groin injury players obtaining lower values in all subscales. HAGOS scores differed between the 5SST pain intensity groups ($p < 0.01$).
Conclusions: Male players had higher odds of having had a groin injury in the previous season compared to female players. Players with pain during 5SST and previous season groin injury reported functional deficits, while strength remains identical to their healthy counterparts.

1. Introduction

Groin pain (GP) is a complex problem in sporting environments due to its high incidence in sports that require changes of direction, such as football or ice hockey (Werner, Hägglund, Ekstrand, & Waldén, 2019; Wörner, Thorborg, Clarsen, & Eek, 2022). Some athletes that suffer from this condition keep playing while having a decrease in their performance (non-time-loss injury) while others have to stop participating completely (time-loss injury) (Esteve et al., 2020). In addition, different entities can refer the pain to the same region, making the evaluation and treatment of this pathology difficult (Drew et al., 2017; Serner et al., 2022). In this regard, the literature has increased in recent years since the publication of the Doha Agreement, where a common terminology was defined (Weir et al., 2015). The seasonal prevalence of time-loss GP varies between 13.6% and 32.5% in different team sports, with soccer being the one that registers the highest number of injured athletes (Mercurio et al., 2022). However, prevalence is higher when non-time-loss cases are considered, reaching a seasonal prevalence of 45–59% in some cohorts (Harøy et al., 2017; Wörner et al., 2022), Only 10–34% of all cases are time-loss, which emphasizes the importance of recording the entire spectrum.

In rink hockey, the time-loss injury incidence rates for all types of injuries vary between 3.2 and 9.7 injuries per 1000 h of exposure (de Pablo, Peña, Moreno, Rodas, & Casals, 2022). Groin injuries in rink hockey were first characterized 30 years ago, with players reporting pain in the adductor longus insertion, which irradiated to the abdominal area in certain patients (Cabrafiga & Escobar, 1991). The authors hypothesized that these muscles were injured due to

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repeated side braking with roller skates and used the term *adductor overload* to describe this phenomenon. Later, other researchers reported that 11% of all injuries collected in professional rink hockey players were adductor tendinopathies (Florit et al., 2019). A recent study observed that the injury incidence for the groin region was 0.71/1000 h of exposure, with 16% of the time-loss injuries recorded affecting this area (Quintana-Cepedal, Rodríguez, Crespo, del Valle, & Olmedillas, 2022). Taking into account that a player performs more than 300 sudden accelerations and decelerations every session (Fernández, Moya, Cadefau, & Carmona, 2021), it is not surprising to find that groin injuries are frequent in this discipline.

Proposed risk factors that favour the development of GP are: previous groin injury, adductor and abductor muscle weakness, male athletes or achieving worse scores in function questionnaires (Bourne et al., 2020; Whittaker, Small, Maffey, & Emery, 2015). Adductor strength is easily measurable using a handheld dynamometer (HHD) with the participant laying in the supine position (Light & Thorborg, 2016). Higher strength has been observed to be a protective factor for the development of groin injuries (Esteve et al., 2022). Recent studies have found adductor strength to be the same irrespective of the history of previous groin injury (Wörner, Thorborg, Clarsen, & Eek, 2021). Function is principally evaluated using the Hip and Groin Outcome Score (HAGOS), a patient-reported outcome measure consistently used in the assessment of players with groin problems. In this regard, investigations have shown that athletes that have previously suffered GP achieve worse scores (Carolan et al., 2022; DeLang et al., 2021) and having lower values in preseason testing predispose the players to a new episode of GP (Bourne et al., 2020).

Due to the poor characterization of this injury in rink hockey, the purpose of this study was to: (1) assess groin pain prevalence (past season and current) between genders, playing position and category; (2) investigate groin health indicators such as functionality, adductor strength and pain during the 5SST; (3) compare adductor strength and functionality between athletes with or without past season time-loss groin pain, or reporting pain on the 5SST in a sample of rink hockey players.

2. Materials and methods

2.1. Design

The reporting of the present cross-sectional study follows the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) statement (Vandenbroucke et al., 2007). This study was registered at ClinicalTrials.gov (NCT05273008), and all participants signed the informed consent prior to participating in the study. The Institutional review board approved this study (Code: 2021.543). The Principles of the Declaration of Helsinki were followed at all times.

2.2. Procedure

Teams from Spain participating in the first (Ok Liga), second (Ok Plata) and third (Ok Bronce) division leagues were contacted via telephone or email in September 2021 and asked to participate in the study. An information sheet was sent to the teams explaining the measurement procedure in detail and videos with the strength assessment explanation were also provided. Team members could ask any questions in relation to the study and every individual player decided if they wanted to participate. Data compilation started in October 2021 and ran until June 2022.

2.3. Participants

In total, 26 teams (19 male) were invited to participate in the study, of which all agreed to participate. Demographic characteristics are presented in Table 1 split by gender. Any player that was part of the corresponding team could participate, unless any lower limb injury had been sustained in the previous 3 months that prevented participation. If any of the athletes were not present on the day of the assessment, they were invited to participate in the online questionnaire which covered participant characteristics, history of previous episodes of GP and HAGOS scores. All the sample fulfilled the online questionnaire and 134 participants (14 teams) performed strength measurements. Fig. 1 depicts a flow diagram of the number of participants included in each analysis.

2.4. Measurements

Data collection consisted of demographics and injury history (all time, past season and current) captured with an online form (https://forms.gle/mTb3AQFrjemTyYoQ7); and maximal strength measurements with corresponding pain values (5SST). Participant characteristics, playing level, history of previous GP episodes regarding both time and non-time-loss, and HAGOS scores were captured with the online form. History of previous GP episodes was recorded using the following questions to evaluate the entire spectrum: (1) Did you suffer from pain in the groin region anytime since you started playing rink hockey (all-time groin pain prevalence)?; (2) Did you suffer from pain in the groin region anytime since you started playing rink hockey that prevented you from participating in at least one whole training session or match (all-time time-loss groin pain prevalence)?; (3) Did you suffer from pain in the groin region throughout the past season (groin pain seasonal prevalence)?; (4) Did you suffer from pain in the groin region throughout the past season that prevented you from participating in at least one whole training session or match (time-loss groin pain seasonal prevalence)? Current groin pain prevalence was calculated using a cut-off value of 75 points in the HAGOS Sports subscale, participants reporting lower scores were considered to have groin pain at the time of the assessment (Wollin, Thorborg, Welvaert, & Pizzari, 2018). For function, the HAGOS consists of 37 items across 6 subscales: symptoms, pain, activities of daily living, sporting activities, participation in physical activities and quality of life. Each is expressed as a value from 0 to 100, where 0 means the worst possible function and 100 is the best. Fourteen (n = 133) teams took part in the strength measurements due to availability. Adductor force was recorded in a relaxed state and assessed using the 5SST (Drew et al., 2016; Light & Thorborg, 2016). In short, the test consists of an isometric and progressive contraction of the adductor muscles. The participant is laid in a supine position on the examination table with knees completely extended and 0° hip flexion. The examiner places the forearm between the ankles (right above the malleolus) with the HHD (ActivForce 2, ActivForce, CA) in one hand and requests the athlete to apply progressive adduction force for 5 s; verbal encouragement is provided during the test to ensure the athlete performs the maximal effort (Fig. 2). After each repetition, the examiner annotated the peak force value (N) and the pain reported by the participant around the groin area on a numeric rating scale (NRS). Pain during the 5SST is further categorized into intensity groups, a score of 0–2 is considered low, 3–5 is medium and 6–10 is considered high intensity (Thorborg, Branci, Nielsen, Langelund, & Hölmich, 2017). Before commencing, two submaximal trials were performed to accustom the participants to the test and the examination was repeated three times per side. Leg length and weight were used to calculate torque, which was obtained using the formula Nm/Kg, where N is the strength value in

Table 1
Demographic characteristics reported by gender.

	Female (n = 68, 27%)	Male (n = 183, 73%)	All (n = 251)
Age in years [Median (IQR)]	20 (17–22)	21 (18–25)	20 (18–25)
Height in cm [Median (IQR)]	163 (160–169)	177 (172–181)	174 (168–180)
Weight in kg [Mean (SD)]	62 (7.2)	75.3 (9.8)	71.7 (11)
BMI [Median (IQR)]	22.8 (21.5–24.4)	23.8 (22–25.5)	23.5 (22–25)
Playing position, outfield player [N (%)]	52 (76.5%)	143 (78%)	195 (78%)
Playing category, divisions 1st-2nd [N (%)]	65 (95.6%)	36 (20%)	101 (40%)
All time GP, yes [N (%)]	46 (67%)	111 (61%)	157 (63%)
All time GP time- loss, yes [N (%)]	24 (35%)	83 (45%)	107 (43%)

BMI= Body mass index, GP = Groin pain.

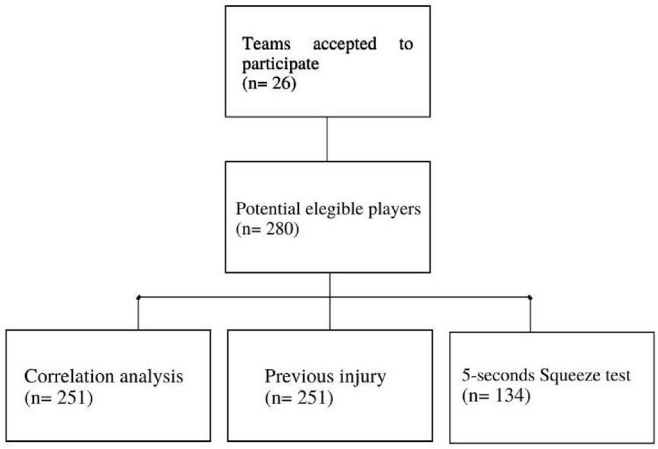

Fig. 1. Flow diagram of the population included in each analysis.

Fig. 2. Demonstration of the 5 seconds-Squeeze-Test.

Newtons, m is the leg length and Kg is the participant weight. Leg length was measured from the anterior superior iliac spine to the medial malleolus, minus 5 cm.

2.5. Statistical analysis

Data analysis was performed using SPSS Statistics 27 (IBM). The significance level was set to $p < 0.05$. Comparative analyses between gender, playing position and category with history of past season or current GP prevalence were performed with the χ^2 test and odds ratio (OR). For seasonal prevalence of time-loss GP, comparison between male and female players was adjusted considering playing category and position. Normality assessment was performed by visually inspecting histograms and using the Kolmogorov-Smirnov test. Differences in adductor strength and function between subjects with past season time-loss GP and those without, separated by gender, were evaluated with an independent *t*-test or Mann-Whitney *U* test when appropriate. Differences in strength (ANOVA) and function (Kruskal-Wallis test) were assessed for 5SST pain groups (NRS: 0–2, NRS: 3–5, NRS: 6–10). When significance was found, the post hoc Games-Howell test was used. The ES was calculated with Cohen's d (parametric), r or η^2 (non-parametric) (Lakens, 2013). No sample size calculation was performed prior to data collection due to the exploratory nature of the study; the aim was to include as many players as possible from the target population.

3. Results

3.1. Past season and current groin pain prevalence

Groin pain seasonal prevalence was 39%, of which 53% of the cases were time-loss. Male and female time-loss GP past-season prevalence was 25% and 9%, respectively. Male players had 3.5 higher odds of having sustained an episode of time-loss GP in the previous season ($p < 0.005$; 95% CI = 1.4–8.5) compared to females, while players competing at a higher level had 7 ($p < 0.001$; 95% CI 2.4–20.4). After adjusting for playing position, male outfield players had higher odds of having sustained time-loss GP ($p < 0.005$; OR = 4.34; 95% CI 1.4–12.8) in the previous season compared to female outfield players. However, odds of having sustained an episode of time-loss GP in male goalkeepers did not reach significance ($p = 0.7$), observing 1.7 (95% CI 0.3–9.3) favoring males. Regarding all past season prevalence (non-time-loss and time-loss), no differences were observed comparing genders (m: 40.4% vs f: 35%; OR = 1.24; $p = 0.471$) When past season time-loss groin pain prevalence was compared between 1st/2nd division against 3rd division, and outfield players versus goalkeepers, no differences in injury prevalence were observed ($p = 0.36$–0.98). Current groin pain prevalence was higher in male players (m: 13% vs f: 4%), males had 3.2 higher odds of having groin pain at the time of data collection despite this difference not reaching statistical significance ($p = 0.06$).

3.2. Player analysis with and without previous season time-loss groin pain

Stratified analysis of functional outcomes by gender showed differences in HAGOS subscales scores in players with and without time-loss GP in the previous season (Table 2). Significance was achieved for all HAGOS subscales in male participants (ES

Table 2
Differences in HAGOS subscales between players with and without previous season time-loss groin pain.

		TLGP	Control	p-value	ES (*r*)	
Symptoms	m	68.75 (65.6)	81.2 (43.7)	< **.001**	.31	Medium
	f	76.5 (41)	78 (56)	.56	.06	Small
Pain	m	92.5 (45)	97.5 (27.5)	< **.001**	.29	Small
	f	97.5 (17.5)	97.5 (32)	.72	.04	Small
ADL	m	95 (45)	100 (35)	< **.001**	.27	Small
	f	97.5 (15)	100 (30)	.51	.08	Small
Sports	m	86 (72)	100 (37.5)	< **.001**	.31	Medium
	f	90.6 (22)	98.5 (31)	.14	.18	Small
PiPA	m	100 (100)	100 (50)	**.04**	.15	Small
	f	87.5 (12.5)	100 (25)	.23	.15	Small
QoL	m	95 (90)	100 (35)	< **.001**	.47	Medium
	f	82.5 (55)	100 (40)	**.024**	.27	Small

m = male, f = female, TLGP = Time-loss groin pain (m = 46, f = 6), Controls (m = 137, f = 62). ADL = Activities of Daily Living, PiPA = Participation in Physical Activity. QoL = Quality of Life. Data is reported as median (IQR).

(*r*) = 0.15–0.47) and in the quality of life subscale for the female athlete group (ES (*r*) = 0.27).

There were non-significant strength differences between groups of male players with (2.8 Nm/Kg [SD = 0.6]) or without 3.01 Nm/Kg [SD = 0.84]) past season time-loss groin pain (MD = 0.13 Nm/Kg [95% CI = −0.28–0.53], p = 0.53, ES (d) = 0.17), and this same pattern (1.78 Nm/Kg [SD = 0.4] vs 1.96 Nm/Kg [SD = 0.56]) was observed in female players (MD = 0.17 Nm/Kg [95% CI = −0.42–0.77], p = 0.55, ES (d) = 0.36).

3.3. Comparisons for the 5-second squeeze test

Players with low (NRS 0–2), medium (NRS 3–5), and high (NRS 6–10) pain intensity levels during the 5SST differed from each other regarding self-reported symptoms, pain, activities of daily living, sports, and quality of life HAGOS subscales scores (Table 3). However, no differences were observed for participation in physical activity (p = 0.39) or adductor strength (Low = 2.72 Nm/Kg [SD = 0.87]; Medium = 2.77 Nm/Kg [SD = 1.1]; High = 2.8 Nm/Kg [SD = 0.6]; p = 0.79).

4. Discussion

We investigated the epidemiology of groin injuries and whether strength and function were different in a population of rink hockey players with or without previous season or current groin pain. The main findings of this study were that groin injuries were more common in male athletes while non-time-loss groin pain was equally distributed in both sexes. Athletes with past season time-loss groin pain and those reporting pain during the 5SST scored lower self-reported function results but no differences were observed in strength measurements compared to players without past season time-loss groin pain or to those reporting 0–2 NRS pain during the 5SST.

We found a seasonal prevalence of 39%, of which half of the cases were time-loss. Males had higher odds of having sustained a time-loss groin injury compared to females. Groin injury prevalence appear to rate higher in male athletes among different multi-directional team sports. In footballers, two to 3.1 male groin injuries have been observed for every female case (Harøy et al., 2017; Karlsson, Dahan, Magnusson, Nyquist, & Rosengren, 2014). More groin injuries are reported in male ice hockey players despite non-significant differences being observed (RR = 1.4 95% CI = 0.75–2.5) (Orchard, 2015). In this regard, one study found no differences between gender prevalence when playing category was taken into consideration (Harøy et al., 2017). Wörner et al. studied the seasonal prevalence of GP in female ice hockey and observed rates comparable to male players, since 26% of the participants suffered an episode of time-loss injury (Wörner, Thorborg, & Eek, 2020a). However, when we compared past season time-loss GP prevalence between 1st-2nd division male and female players, the odds of having sustained a groin injury were even higher for males. Anatomical variations related to the hip and pelvis morphology could explain prevalence rates (Schache, Woodley, Schilders, Orchard, & Crossley, 2017), but no conclusion can be extracted to date that can explain these differences. Male time-loss prevalence was 25%, which is in accordance with studies on different disciplines that observe rates ranging between 25 and 32.5% in football, ice hockey, futsal, or basketball. On the contrary, prevalence was higher than in volleyball (13.6%) and water polo (17.6%) (Mercurio et al., 2022; Wörner, Thorborg, & Eek, 2020b). Current prevalence in male athletes was 13%, which is similar to that of football (12%) and ice hockey (14%) (Esteve et al., 2020; Wörner et al., 2022).

Self-reported function was evaluated using the HAGOS questionnaire, athletes with past season time-loss GP achieved worse function scores than those without. Similarly, participants reporting higher pain during 5SST scored worse results in 5/6 HAGOS subscales. Low to moderate effect sizes were observed in all HAGOS subscales for males and in the quality of life subscale for female participants. HAGOS is consistently used in sporting environment to differentiate between athletes with or without groin pain; football players score worse results in all subscales when they have suffered a groin injury in the previous season (p < 0.001) (Thorborg, Branci, Stensbirk, Jensen, & Hölmich, 2014; Thorborg, Rathleff, Petersen, Branci, & Hölmich, 2017). Results seem to be consistent among other multi-directional team sports; elite Gaelic football and hurling players with past season groin pain achieve lower scores in all subscales (p < 0.001; ES (r) = 0.36–0.73) (Carolan et al., 2022). When we studied the female participants, only the quality of life subscale was lower among players with time-loss groin pain during the past season compared to those without. However, caution is advised in the interpretations of these results due to the low number of female players (n = 6) that had sustained an episode of time-loss GP during the previous season, which leads to a low statistical power. This differs from other results since both female football (p < 0.001) and ice hockey (p = 0.011 to <0.001) players

Table 3
Comparison for HAGOS subscales and 5-second Squeeze Test (0–2, 3–5, 6–10).

	NRS 0-2	NRS 3-5	NRS 6-10	p- value	Effect size (η^2)	
Symptoms	82 (43.7)	73.4 (56.2)	68.7 (21)	< **.001**	0.09	Medium
Pain	97.5 (20)	92.5 (25)	95 (42)	< **.001**	0.09	Medium
ADL	100 (30)	97.5 (35)	95 (20)	< **.01**	0.07	Medium
Sports	100 (37.5)	90.6 (37.5)	84.4 (65.6)	< **.001**	0.13	Medium
PiPA	100 (50)	94 (62.5)	100 (25)	.39	–	–
QoL	100 (35)	87.5 (55)	95 (25)	< **.01**	0.07	Medium

ADL = Activities of Daily Living, PiPA = Participation in Physical Activities, QoL = .
Quality of Life, NRS= Numeric Rating Scale. NRS 0–2 (n = 106), NRS 3–5 (n = 18), NRS 6–10 (n = 9). Data is reported as median (IQR).

display worse function in all HAGOS subscales (Langhout & Tak, 2019; Wörner et al., 2020a). One possible explanation could be the differences characterising each sport, which increases the importance of performing research in various disciplines to obtain reliable data for a specific sport. The same pattern is observed when NRS pain is used as cut-off values. Worse HAGOS scores were obtained by players with NRS 3–5 (medium) and lower values were collected from players reporting NRS 6–10 (high) pain intensity (Thorborg, Branci, et al., 2017; Wörner, Thorborg, & Eek, 2019), which is in accordance with our findings.

Adductor strength was compared using pain on the 5SST as the independent variable. Pain during the 5SST is inversely correlated with adductor strength (Wörner et al., 2019). At this regard, our participants displayed similar maximal strength output irrespective of the pain reported ($p = 0.79$) and no significant differences were reported for strength regarding past season episodes of time-loss groin injury ($p = 0.53–0.55$). Ice hockey players with past season GP achieved similar adductor strength to those without ($p = 0.15$), which is in accordance with our findings (Wörner et al., 2021). It could be hypothesized that adductor strength might not be the cornerstone of groin pain; other factors (injury history, self-reported function or gender) must be taken into account when screening and rehabilitating athletes with this injury.

4.1. Practical implications

Physicians, coaches and trainers can expect two players to miss at least one session throughout the season and up to 40% of the team will report some groin problems. Tools like the HAGOS questionnaire should be implemented in rink hockey to screen during preseason, since it can detect functional deficits from the current or previous season. Completing the entire questionnaire may take too much time; therefore, the authors recommend using the sports subscale since it displays larger differences ($p < 0.001$; ES (η^2) = 0.13) and can be completed more quickly, improving player buy-in. 5SST can be used in the decision making of player availability considering pain intensity reported (Thorborg, Branci, et al., 2017).

4.2. Limitations

One limitation is the lack of controlling lay-off days due to injury; the longer the player is unavailable to participate, the larger the deficits observed might be (Wörner et al., 2017). Another limitation is that strength measurements were performed isometrically, but the action of braking in rink hockey may require an eccentric action instead of an isometric contraction; this could be the reason why no strength differences were observed. Lastly, the cross-sectional design did not allow us to measure injury incidence or effects of the factors studied on groin pain prevalence, prospective studies are necessary to account for this limitation. However, this article has several strengths. The population consisted of male and female players competing in the higher standards of rink hockey and in amateur leagues. Furthermore, information on the main risk factors proposed was collected together. Future studies could focus on task deficits or adolescent population epidemiology, since non time-loss groin problems might affect performance and adolescent athletes may be at risk of sustaining GP, making them susceptible to developing the same injury in the future.

5. Conclusion

Groin pain is common in rink hockey players, irrespective of gender. Our participants that suffered a groin injury during the previous season reported functional deficits, suggesting that function is not recovered from the previous year, but there were no strength deficits. Furthermore, adductor strength cannot distinguish players with or without current groin pain when performing the 5SST.

Ethical approval

This work was approved by the ethical committee related to the University in which the research was performed. All subjects provided their written informed consent prior to their participation in the study.

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Ethical statement

This study has been approved by the local ethics committee (Comité Ética de la Investigación del Principado de Asturias: Nº = 2021.543). Informed consent was signed by participants taking part in the adductor strength assessment. For participants that answered the online questionnaire exclusively, it was not necessary to fill the informed consent.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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