Worse self-reported outcomes but no limitations in performance-based measures in patients with long-standing hip and groin pain compared with healthy controls

Wörner, Tobias; Sigurdsson, Haraldur B; Pålsson, Anders; Kostogiannis, Ioannis; Ageberg, Eva

Published in:
Knee Surgery, Sports Traumatology, Arthroscopy

DOI:
10.1007/s00167-016-4101-6

2017

Document Version:
Peer reviewed version (aka post-print)

Worse self-reported outcomes but no limitations in performance-based measures in patients with long-standing hip and groin pain compared with healthy controls

Tobias Wörner*[1], Haraldur B. Sigurðsson[1]*, Anders Pålsson[1], Ioannis Kostogiannis[1, 2], Eva Ageberg[1]

* Equal contribution

[1] *Department of Health Sciences, Lund University, Lund, Sweden*

[2] *Department of Clinical Sciences, Orthopaedics, Skåne University Hospital, Sweden*

Corresponding author:

Tobias Wörner

+46 72 0404559

tobias.worner@med.lu.se

Abstract

Purpose

This study aimed to evaluate patient-reported outcomes as well as lower extremity and trunk muscle function in patients with long-standing hip and groin pain, in comparison to matched, healthy controls. It was hypothesized that patients with long-standing hip and groin pain would report more deficiency on the Copenhagen Hip and Groin Outcome Score (HAGOS), and have worse outcomes on performance-based measures than healthy controls.

Methods

Nineteen patients with long-standing hip and groin pain and 19 healthy, activity level-, age-, gender-, and weight-matched controls were assessed with the HAGOS for self-reported outcomes, and a parallel squat (w/kg), single leg triple jump (cm), single leg rise (n), barbell roll-out (% of height), and plank-test (s) for performance-based measures. Independent sample t-test was performed to assess between-group differences. The paired t-test was used to analyze between-limb differences in unilateral performance tasks.

Results

The patients had worse scores than the controls in all HAGOS-subscales ($p \leq 0.001$), while no statistically significant differences were observed for any performance measure between groups or between symptomatic and non-symptomatic limbs.

Conclusions

Despite significant self-reported functional limitations on the HAGOS, there were no significant differences between groups in performance-based strength or power measures. The results of this study highlight the need to identify performance-based measures, sensitive to functional deficiencies in patients with long-standing hip and groin pain in order to complement the clinical picture obtained by patient-reported outcomes such as the HAGOS.

Case-control, Level of evidence III

Key words: Hip Joint, Groin, Musculoskeletal Pain, Athletic Performance, Muscle Strength, Self Report.

Introduction

Longstanding hip and groin pain (LHGP) is a commonly encountered condition in various team sports involving sprinting, cutting, kicking, and twisting [10]. In soccer, groin injuries account for up to 19% of all injuries [30], while the estimated prevalence may be as high as 70% [26]. A recent systematic review, reported a high rate of hip and groin injuries in ice hockey and football code sports such as Australian football, Gaelic football, and rugby [17].

In a systematic review of diagnostics of patients with LHGP, Jansen et al [11] found multiple diagnoses for LHGP in the majority of the subjects, further illustrating the challenge of identifying the causative pathology and the target for therapeutic intervention. Treatment strategies may, thus, remain ineffective due to misclassification of patients into diagnostic-entities, based on specific pathologies [9]. A recent consensus statement by experts in the field recommended classifying LHGP in five clinical entities; adductor-, iliopsoas-, inguinal-, pubic-, and hip-related groin pain [31].

Patient reported outcomes (PROs) are considered the gold standard in the assessment of pain and function, and quality of life (QoL) in musculoskeletal assessment [27] . The Copenhagen Hip and Groin Outcome Score (HAGOS) is a reliable and valid tool and currently the only PRO evaluating both hip and groin pain [25].

Currently, clinical evaluation of the hip joint includes range of motion, isolated muscle testing, and pain provocation tests [14] while performance-based measures

(PBMs) of physical function are infrequently performed [13]. Performance in sports requires quick production of high muscular force. Consequently, strength and power are important components of muscle function, reflecting sport-specific demands [1]. A recent review on functional limitations in hip-related LHGP highlights the need to investigate strength in all planes of movement and compare with an asymptomatic control group [6]. In a systematic review and meta-analysis, Mosler et al. [15] reported strong evidence on PROs ability to differentiate between patients with LHGP and healthy controls but identified no studies on PBMs. Thus, studies on physical performance in patients with LHGP are needed in order to identify potential functional limitations and objective measures able to detect these deficiencies. Such knowledge will help in the design of appropriate treatment for this population.

Therefore, the aim was to compare patients with LHGP to activity level-, age-, weight- and gender-matched controls regarding patient-reported outcomes and objectively measured performance of lower extremity- and trunk muscle function. It was expected that patients with LHGP would (1) report worse outcomes than controls, (2) display worse trunk and lower extremity performance compared with their control counterparts, and (3) perform worse in functional tasks on their symptomatic limb compared with their non-symptomatic limb.

MATERIALS AND METHODS

Inclusion criteria for participants with LHGP were: i) age 18-55 years, and ii) hip/groin pain for more than three months with or without other hip-related symptoms, such as catching, clicking or giving way.

Patients were excluded if they reported insufficient limitations on the HAGOS, which was defined as: i) combined score of < 2 on items PA1: "Are you able to participate in your preferred physical activities for as long as you would like?" and PA2: "Are you able to participate in your preferred physical activities at your normal performance level?" and/or ii) score of <1 on item Q5: "Do you feel restricted due to your hip and/or groin problem?" and/or iii) other musculoskeletal co-morbidities overriding hip-related symptoms and dysfunction.

Inclusion criteria for control participants were: 1) age 18-55 years, and ii) no current hip/groin pain or other musculoskeletal problems. Controls were similarly excluded if they reported limitations on the HAGOS, defined as i) >=2 on items PA1: "Are you able to participate in your preferred physical activities for as long as you would like?" and PA2: "Are you able to participate in your preferred physical activities at your normal performance level?", or ii) score of >=1 on item Q5: "Do you feel restricted due to your hip and/or groin problem?".

Exclusion criteria for all participants were: i) previous hip replacement surgery, ii) musculoskeletal pain, injury or dysfunction from areas other than the hip and groin on the day of testing and/or iii) language barriers defined as the inability to follow verbal instructions in Swedish or English and/or inability to fill out the questionnaires in Swedish or English.

Recruitment

Participants with or without LHGP were recruited and assessed between February and May 2014. Recruitment advertisement was sent to 33 patients at the

Department of Orthopedics, Skåne University hospital, to 40 local sports clubs, 15 local physiotherapy clinics, and students of the Faculty of Medicine, Lund University. A total number of 34 potentially eligible participants with long-standing hip and groin pain (LHGP) contacted the investigators. Three participants declined participation after receiving further information regarding the testing. Seven out of the remaining 31 potential participants could not be scheduled for testing due to time constraints and five participants did not meet the inclusion criteria. Nineteen participants with LHGP were tested and analyzed, three of which had received previous hip arthroscopy and 11 of which received physiotherapy treatment within three months prior to the study.

Twenty control participants were recruited by convenience from the student population of the Faculty of Medicine, Lund University (N=12) and local sports clubs (N=8). One individual was excluded after failing to meet the HAGOS inclusion criteria, yielding 19 control participants for testing and analysis.

LHGP- and control groups were similar in terms of age, height, trainings-load and activity level according to the Tegner activity scale (TAS) [22] (Table 1).

Assessment

The participants performed the tests in the order that they appear below.

Self-reported outcomes

The HAGOS questionnaire was administered in English [25], or Swedish language [23], as appropriate. The HAGOS evaluates the persons' perception about their hip and/or groin disability and associated problems over six different subscales, including Pain, Symptoms, Physical function in daily living, physical

function in Sport and Recreation, Participation in Physical Activity, and Quality of life. HAGOS has proven to be a reliable (ICC 0.82-0.92; SEM 6.4-12.2%) and valid tool in the assessment of LHGP in a young to middle-aged population [25]. HAGOS scores were converted into percentages with 0% representing the maximum and 100% the minimum amount of pain and disability.

Performance-based measures

Prior to measurement, participants performed a 5-minute warm up on a stationary bike and non-fatiguing functional tasks. Participants were asked to wear training-shoes and -shorts of their own choice. Symptomatic participants were randomized to start on either the symptomatic or non-symptomatic leg. Controls were randomized to start on either the right or left leg. Subsequently, five performance-based measures were performed, in the order that they appear below, using standardized verbal instructions.

Single leg triple jump (SLTJ)

The SLTJ measures repeated hop performance (cm), which requires a high degree of power output relative to body weight. The test protocol, utilized in this study, has been found reliable (ICC = 0.88; SEM = 4.32%) and valid in young to middle-aged patients following anterior cruciate ligament reconstruction [18].To ensure that the jumps were maximal, the protocol was modified to allow the non-tested leg to be used for balance upon the last landing. Participants performed three maximal jumps. Additional trials were performed if the participants improved more than 10 cm on the last attempt compared to previous jumps.

Parallel squat

This test measures maximal lower extremity power. A linear encoder, connected to a pc-compatible computer running Windows 7 [Microsoft corporation, U.S.A.] and Muscle Lab 8 software [Ergotest Innovation AS, Norway] was attached to a smith-machine barbell. The speed and displacement of the barbell were measured to calculate the maximum power (average W) over the entire concentric movement. The parallel squat was performed as described and found reliable by Comfort et al. (2014)[5] for maximum strength testing (ICC 0.99), with a range of motion where the hip crease was required to pass below the height of the patella. The load power profile, previously described and found reliable (ICC 0.74-0.94) by Sheppard et al. (2008) [21]for jump squats, was modified by using five initial loads to estimate the power-curve with a final measurement at the predicted maximum power load.

Roll out

A barbell roll out was performed to test the ability of the abdominal muscles to eccentrically control lumbar spine position through maximal range of motion. A rotating barbell loaded to 30kg (20kg barbell loaded with two 5 kg plates, Eleiko Sports, Sweden), with a linear encoder attached, was used to measure the distance the bar travelled. Participants warmed up by performing 10 repetitions of a dynamic roll out, with self-selected grip, weight bearing on their knees. After 1-minute rest, participants lifted their knees and rolled the barbell, while maintaining control over the lower back. The test leader visually observed the movement and recorded the distance (in cm) as soon as the lumbar spine position was lost. The average of 3 attempts, with a 1-minute rest in-between, was used as outcome to account for possible measurement error caused by visual assessment

of lumbar spine position. Test results were reported as a percentage of the subjects' height. This is a novel test developed by the authors, and was pilot tested for calibration purposes prior to the start of the study.

Single leg rise

The single-leg rise test was performed as previously described [29], modified by using the same range of motion as that during the parallel squat and by initiating the first repetition from a seated position. Trunk motion was allowed to produce inertia, while arms were to be held straight in front of the body (approx. 90° shoulder flexion). The number of repetitions, performed without any break between repetitions, served as the outcome. A resting time of 5 minutes was taken between legs.

Front plank

Isometric abdominal muscle endurance was assessed by the plank test as described by Nuzzo et al. (2013) [16]. The test was reported reliable (Pearson's correlation coefficient = 0.78) [20]. Participants were asked to maintain the position as long as possible. If alterations of the neutral low-back position were observed, a warning was given. After a maximum of two warnings, or gross failure to maintain the test position, the test was terminated and the time (seconds) was recorded.

This study was approved by the Regional Ethical Review Board in Lund, Sweden (Dnr 2014/12). All participants provided written informed consent.

Statistical analysis

Statistical analysis was performed using SPSS Statistics 22 (IBM Software). Gender, or history of surgery, did not prove to be confounders in the analysis. Therefore, patients were analyzed as one group.

The independent sample t-test was performed to test between-group differences, and the paired-samples t-test was used for between-limb differences. To test for differences in the SLTJ and the single leg rise, the symptomatic leg of the LHGP group was compared to the right leg of controls, and asymptomatic leg to the left leg of controls. The Mann-Whitney U test was used to assess between-group differences in activity level, and the Wilcoxon Signed Ranks test for differences in activity level before LHGP onset versus at time of the study.

Due to the exploratory character of the study and the lack of available data on PBMs, no sample-size calculation was performed prior to the study.

RESULTS

Participants with LHGP had worse self-reported outcomes in all HAGOS-subscales compared with controls (Figure 1). The largest difference between the groups was observed for the subscale quality of life, followed by physical activity, sports and recreation function, pain, symptoms, and activities of daily living (Table 2).

No significant differences were found between groups (Table 3) or between symptomatic and asymptomatic legs of the LGHP group (Table 4) for any of the outcome measures.

Discussion

The principal findings were that the participants with LHGP reported worse scores on all subscales of the HAGOS compared with the control group, but that no differences were detected between groups, or between the symptomatic and non-symptomatic limbs, for performance-based measures.

Participants with LHGP reported significantly worse HAGOS scores compared with controls, with the largest differences observed for the subscales quality of life, physical activity, and sport/rec. Our two groups appear to be representative with regard to their HAGOS scores when compared to previous research with similar populations [19,24,25].

To our knowledge, the current study is the first to investigate both uni- and bilateral functional performance in the sagittal plane in this population. Decreased isolated muscle strength [12] and impaired single-leg squat performance [3] have been observed in patients following hip arthroscopy when compared to healthy controls. Because these studies did not assess patients' function prior to surgery, is unclear if the observed limitations were due to the surgical procedure or LHGP. Furthermore, previous research reports that compensatory strengthening, or weakening, as well as pain-inhibition may alter strength ratios in patients with

LHGP [26,7]. Future research may assess whether altered strength ratios or isolated muscle strength influence multi-joint task performance in the sagittal plane.

The findings of worse PROs among patients compared with controls, but no differences between groups for measures of muscle function, have also been observed in patients with ankle instability [33] and in patients following meniscectomy [28]. Proposed explanations were that PBMs were either not sensitive enough to detect the intended impairments [33] or that factors other than muscle strength accounted for the limitations reported by the patients [28].

It cannot be excluded that the participants in the present study were able to execute the PBMs without deficiencies but with pain. The majority of hip/groin pain problems in sports are overuse injuries [32], but athletes may play and train despite pain [4]. Therefore, future studies should consider evaluating perceived pain during assessment of PBMs.

Some limitations of the current study need to be acknowledged. Similar to previous research on LHGP [25], we used broad inclusion criteria, allowing a wide range of clinical entities. Further studies in different subgroups with LHGP are needed to assess possible differences in PROs and PBMs between patients and controls. Due to the exploratory nature of the present study and the lack of previous PBM data, no power calculation was performed prior to the study. However, our results may serve as basis for power calculations for future studies on PBMs in patients with LHGP. The participants with LHGP had a median decrease of 4 points on the TAS from onset of symptoms upon entering the study.

The controls were matched with regard to the patients' current, instead of the previous, higher, activity level. Thus, a systematic error may have been introduced, resulting in an underestimation of limitations for PBMs in patients compared to controls. Most of the measurements included in the present study have been found reliable. Reliability remains to be assessed for the barbell rollout, for the single leg rise, and for the combination of the incremental load power profile and the parallel squat maximum strength [21,5].

The results of the present study suggest that our battery of PBMs, measuring lower extremity power or strength, and abdominal strength and endurance, did not detect the limitations reported by patients with LHGP on the HAGOS. Thus, a lack of valid PBMs for this population remains [8]. However, in order to obtain a complete picture of patients' function, clinicians should assess both PROs and PBMs [2]. Currently, clinicians can therefore only be recommended to choose PBMs individualized to each patient's preferred activity and performance level until future studies provide valid PBMs for patients with LHGP.

Conclusions

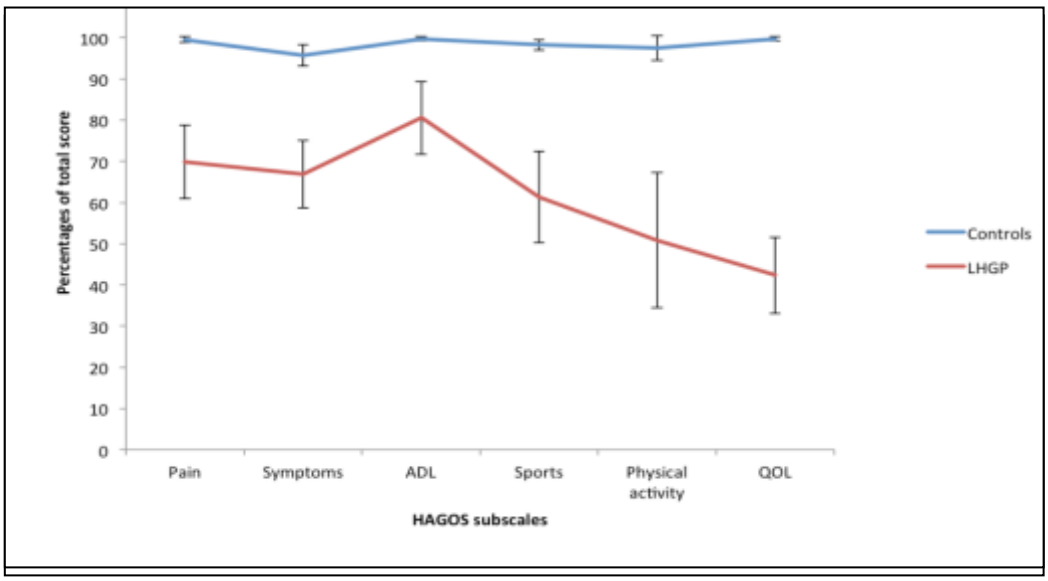
The participants with LHGP reported worse scores on all subscales of the HAGOS compared with healthy controls, with mean differences ranging from 19% to 57%, while no differences were observed between the groups for any of the PBMs.

References

1. American College of Sports M (2009) American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc 41 (3):687-708.
2. Bent NP, Wright CC, Rushton AB, Batt ME (2009) Selecting outcome measures in sports medicine: a guide for practitioners using the example of anterior cruciate ligament rehabilitation. Br J Sports Med 43 (13):1006-1012.
3. Charlton PC, Bryant AL, Kemp JL, Clark RA, Crossley KM, Collins NJ (2015) Single-Leg Squat Performance is Impaired 1 to 2 Years After Hip Arthroscopy. PM R. doi:10.1016/j.pmrj.2015.07.004
4. Clarsen B, Myklebust G, Bahr R (2013) Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology: the Oslo Sports Trauma Research Centre (OSTRC) overuse injury questionnaire. Br J Sports Med 47 (8):495-502.
5. Comfort P, McMahon JJ (2015) Reliability of Maximal Back Squat and Power Clean Performances in Inexperienced Athletes. J Strength Cond Res 29 (11):3089-3096.
6. Diamond LE, Dobson FL, Bennell KL, Wrigley TV, Hodges PW, Hinman RS (2015) Physical impairments and activity limitations in people with femoroacetabular impingement: a systematic review. Br J Sports Med 49 (4):230-242.
7. Diamond LE, Wrigley TV, Hinman RS, Hodges PW, O'Donnell J, Takla A, Bennell KL (2015) Isometric and isokinetic hip strength and agonist/antagonist ratios in symptomatic femoroacetabular impingement. J Sci Med Sport. doi:10.1016/j.jsams.2015.10.002
8. Hegedus EJ, McDonough SM, Bleakley C, Baxter D, Cook CE (2015) Clinician-friendly lower extremity physical performance tests in athletes: a systematic review of measurement properties and correlation with injury. Part 2--the tests for the hip, thigh, foot and ankle including the star excursion balance test. Br J Sports Med 49 (10):649-656.
9. Hegedus EJ, Stern B, Reiman MP, Tarara D, Wright AA (2013) A suggested model for physical examination and conservative treatment of athletic pubalgia. Phys Ther Sport 14 (1):3-16.
10. Jansen JA, Mens JM, Backx FJ, Kolfschoten N, Stam HJ (2008) Treatment of longstanding groin pain in athletes: a systematic review. Scand J Med Sci Sports 18 (3):263-274.
11. Jansen JA, Mens JM, Backx FJ, Stam HJ (2008) Diagnostics in athletes with long-standing groin pain. Scand J Med Sci Sports 18 (6):679-690.
12. Kemp JL, Schache AG, Makdissia M, Pritchard MG, Sims K, Crossley KM (2014) Is hip range of motion and strength impaired in people with hip chondrolabral pathology? Journal of musculoskeletal & neuronal interactions 14 (3):334-342
13. Maffiuletti NA (2010) Assessment of hip and knee muscle function in orthopaedic practice and research. J Bone Joint Surg Am 92 (1):220-229.
14. Martin HD, Kelly BT, Leunig M, Philippon MJ, Clohisy JC, Martin RL, Sekiya JK, Pietrobon R, Mohtadi NG, Sampson TG, Safran MR (2010) The pattern and technique in the clinical evaluation of the adult hip: the common physical examination tests of hip specialists. Arthroscopy 26 (2):161-172.
15. Mosler AB, Agricola R, Weir A, Holmich P, Crossley KM (2015) Which factors differentiate athletes with hip/groin pain from those without? A systematic review with meta-analysis. Br J Sports Med 49 (12):810.
16. Nuzzo JL, Mayer JM (2013) Body mass normalization for isometric tests of muscle endurance. J Strength Cond Res 27 (7):2039-2045.
17. Orchard JW (2015) Men at higher risk of groin injuries in elite team sports: a systematic review. Br J Sports Med 49 (12):798-802.
18. Reid A, Birmingham TB, Stratford PW, Alcock GK, Giffin JR (2007) Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. Phys Ther 87 (3):337-349.
19. Sansone M, Ahlden M, Jonasson P, Thomee C, Sward L, Ohlin A, Baranto A, Karlsson J, Thomee R (2016) Outcome after hip arthroscopy for femoroacetabular impingement in 289 patients with minimum 2-year follow-up. Scand J Med Sci Sports. doi:10.1111/sms.12641
20. Schellenberg KL, Lang JM, Chan KM, Burnham RS (2007) A clinical tool for office assessment of lumbar spine stabilization endurance: prone and supine bridge maneuvers. Am J Phys Med Rehabil 86 (5):380-386.

21. Sheppard JM, Cormack S, Taylor KL, McGuigan MR, Newton RU (2008) Assessing the force-velocity characteristics of the leg extensors in well-trained athletes: the incremental load power profile. J Strength Cond Res 22 (4):1320-1326.
22. Tegner Y, Lysholm J (1985) Rating systems in the evaluation of knee ligament injuries. Clin Orthop Relat Res (198):43-49
23. Thomee R, Jonasson P, Thorborg K, Sansone M, Ahlden M, Thomee C, Karlsson J, Baranto A (2014) Cross-cultural adaptation to Swedish and validation of the Copenhagen Hip and Groin Outcome Score (HAGOS) for pain, symptoms and physical function in patients with hip and groin disability due to femoro-acetabular impingement. Knee Surg Sports Traumatol Arthrosc 22 (4):835-842.
24. Thorborg K, Branci S, Stensbirk F, Jensen J, Holmich P (2014) Copenhagen hip and groin outcome score (HAGOS) in male soccer: reference values for hip and groin injury-free players. Br J Sports Med 48 (7):557-559.
25. Thorborg K, Holmich P, Christensen R, Petersen J, Roos EM (2011) The Copenhagen Hip and Groin Outcome Score (HAGOS): development and validation according to the COSMIN checklist. Br J Sports Med 45 (6):478-491.
26. Thorborg K, Serner A, Petersen J, Madsen TM, Magnusson P, Holmich P (2011) Hip adduction and abduction strength profiles in elite soccer players: implications for clinical evaluation of hip adductor muscle recovery after injury. Am J Sports Med 39 (1):121-126.
27. Thorborg K, Tijssen M, Habets B, Bartels EM, Roos EM, Kemp J, Crossley KM, Holmich P (2015) Patient-Reported Outcome (PRO) questionnaires for young to middle-aged adults with hip and groin disability: a systematic review of the clinimetric evidence. Br J Sports Med 49 (12):812.
28. Thorlund JB, Aagaard P, Roos EM (2010) Thigh muscle strength, functional capacity, and self-reported function in patients at high risk of knee osteoarthritis compared with controls. Arthritis Care Res (Hoboken) 62 (9):1244-1251.
29. Thorstensson CA, Petersson IF, Jacobsson LT, Boegard TL, Roos EM (2004) Reduced functional performance in the lower extremity predicted radiographic knee osteoarthritis five years later. Ann Rheum Dis 63 (4):402-407
30. Walden M, Hagglund M, Ekstrand J (2015) The epidemiology of groin injury in senior football: a systematic review of prospective studies. Br J Sports Med 49 (12):792-797.
31. Weir A, Brukner P, Delahunt E, Ekstrand J, Griffin D, Khan KM, Lovell G, Meyers WC, Muschaweck U, Orchard J, Paajanen H, Philippon M, Reboul G, Robinson P, Schache AG, Schilders E, Serner A, Silvers H, Thorborg K, Tyler T, Verrall G, de Vos RJ, Vuckovic Z, Holmich P (2015) Doha agreement meeting on terminology and definitions in groin pain in athletes. Br J Sports Med 49 (12):768-774.
32. Werner J, Hagglund M, Walden M, Ekstrand J (2009) UEFA injury study: a prospective study of hip and groin injuries in professional football over seven consecutive seasons. Br J Sports Med 43 (13):1036-1040.
33. Wikstrom EA, Tillman MD, Chmielewski TL, Cauraugh JH, Naugle KE, Borsa PA (2009) Self-assessed disability and functional performance in individuals with and without ankle instability: a case control study. J Orthop Sports Phys Ther 39 (6):458-467.

Figure 1: Between group comparison of HAGOS subscales



HAGOS = The Copenhagen Hip and Groin Outcome Score; ADL = activity of daily living; QoL = quality of life; LHGP = long-standing hip and groin pain group. Low percentage of total scores = High severity of symptoms; High percentage of total scores = Low severity of symptoms.

HAGOS = The Copenhagen Hip and Groin Outcome Score; ADL = activity of daily living; QoL = quality of life; LHGP = long-standing hip and groin pain group. Low percentage of total scores = High severity of symptoms; High percentage of total scores = Low severity of symptoms.

Table 1: Subject characteristics

	LHGP (n=19)	**Controls (n=19)**
Age (years) [Mean (SD)]	28 (8.6)	27 (7.3)
Weight (kg) [Mean (SD)]	73.5 (13.9)	73.6 (12.7)
Height (cm) [Mean (SD)]	177.6 (10.8)	175.4 (8.4)
Male participants (n)	12	11
Trainings load (hrs) [Mean (SD)]	6.2 (4.7)	6.6 (4.3)
Experience with strength training (%)	63%	84%
TAS current [Median (IQR)]	5 (4-9)*	6 (4-9)
TAS pre-injury [Median (IQR)]	9 (4-9)	-

LHGP = Long standing hip & groin pain; TAS = Tegner Activity Score; IQR = interquartile range;

* 47% of participants with LHGP changed sport after onset of symptoms

Table 2: Between group comparison of self-reported outcomes

HAGOS scores	LHGP (n = 19)	Control (n = 19)	LHGP vs Controls
	Mean (SD)	Mean (SD)	Mean diff. (95% CI)
Pain	69.9 (19.9)	99.5 (1.6)	29.6 (20.0 – 39.3)*
Symptoms	66.9 (18.2)	95.6 (5.8)	28.7 (19.6 – 37.9)*
ADL	80.5 (19.6)	99.7 (1.1)	19.2 (9.7 – 28.7)*
Sport/Rec	61.3 (24.7)	98.2 (2.9)	36.9 (25.0 – 48.9)*
PA	50.8 (36.5)	97.4 (6.6)	46.6 (28.8 – 64.4)*
QOL	42.4 (20.6)	99.7 (1.1)	57.3 (47.4 – 67.3)*

HAGOS = The Copenhagen Hip and Groin Outcome Score; LHGP = long-standing hip and groin pain group; CI = confidence interval; ADL = activity of daily living; PA=physical activity; QOL = quality of life

* = $p < 0.001$

Table 3: Between group comparison of performance-based measures

Performance-based measure	LHGP (n=19)	Controls (n=19)	LHGP vs Controls
	Mean (SD)	Mean (SD)	Mean diff. (95% CI)
Parallel squat (w/kg)*	14.6 (3.2)	13.7 (3.0)	0.9 (-1.1–2.9)
Single leg triple jump R/asym (cm)**	553 (93)	544 (103)	8 (-59 – 75)
Single leg triple jump L/sym (cm)**	558 (98)	537 (95)	21 (-48 – 89)
Single leg rise. R/asym (n)^	12 (9)	8 (9)	4 (-2–9)
Single leg rise. L/sym (n)^	13 (13)	9 (10)	4 (-4 –11)
Roll out (% of height)°	60 (6)	60 (8)	0 (-5 – 5)
Plank (s)	153 (50)	145 (84)	9 (-36 –54)

CI = confidence interval; LHGP = long-standing hip and groin pain group; W/kg = watts per kilo; R/asym. = right side (control group) vs. asymptomatic side (LHGP group) ; L/sym = left side (control group) vs. symptomatic side (LHGP group) (symptomatic sides were determined according to participants' self reports); % of height = roll out distance in cm, normalized to percentage of participants' height; sec = seconds; rep. = repetition; * Four participants with LHGP reported hip/groin pain during the test; ** One participant with LHGP could not perform the test on the asymptomatic limb, and three participants with LHGP could not perform the test on the symptomatic limb; ^Seven participants with LHGP and two controls reported hip/groin pain during the test; °One participant with LHGP reported pain during the test

Table 4: Within subject comparison of unilateral performance-based measures

Performance based measure	**Symptomatic limb (n=19)**	**Asymptomatic limb (n=19)**	**Asymptomatic vs symptomatic limb**
	Mean (SD)	Mean (SD)	Mean diff. (95% CI)
Single leg triple jump (cm)*	558 (99)	556 (93)	2 (-17 – 19)
Single leg rise (rep)	13 (13)	12 (9)	1 (-2 – 4)

CI = confidence interval; LHGP = long-standing hip and groin pain group; rep. = repetition. * 1 participant with LHGP could not perform the test on the asymptomatic limb and 3 participants with LHGP could not perform the test on the symptomatic limb.