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Intrarater Reliability of the Adductor Squeeze Test in Gaelic Games Athletes

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Context: Groin pain is commonly experienced by athletes involved in field-based sports and is particularly prevalent in Gaelic Games athletes. The adductor squeeze test is commonly used in the assessment of groin pain and injuries. To date, no evidence in the literature provides the reliability of the adductor squeeze test using a sphygmomanometer in assessing the adductor muscle integrity of Gaelic Games athletes. Given the high proportion of groin pain encountered in Gaelic Games athletes, establishing the reliability of the adductor squeeze test will allow clinicians to monitor injury responses and to assess return-to-play criteria.

Objective: To evaluate the intrarater reliability of a commercially available sphygmomanometer for measuring adductor squeeze values in Gaelic Games athletes and to determine if different squeeze values are associated with the 3 commonly used test positions.

Design: Descriptive laboratory study.

Setting: University clinical skills laboratory.

Patients or Other Participants: Eighteen male Gaelic Games athletes without any previous or current history of groin or pelvic pain.

Intervention(s): Each participant performed the adductor squeeze test in 3 positions of hip joint flexion (0°, 45°, and 90°) on 2 test days separated by at least 1 week.

Main Outcome Measure(s): Adductor squeeze test values (mm Hg) quantified by a commercially available sphygmomanometer.

Results: Intrarater reliability intraclass correlation values ranged from 0.89 to 0.92 (intraclass correlation coefficients were 0°, 0.89; 45°, 0.92; and 90°, 0.90). The highest squeeze values were recorded in the 45° of hip flexion test position, and these values differed from those demonstrated in the 0° and 90° hip flexion test positions ($P < .05$).

Conclusions: A commercially available sphygmomanometer is a reliable device for measuring adductor squeeze test values.

Key Words: groin injuries, measurements, rehabilitation, strength

Key Points

- For all 3 test positions, the intrarater reliability of a commercially available sphygmomanometer in assessing adductor squeeze values in Gaelic Games athletes was excellent, with the highest reliability and greatest squeeze values noted in the 45° of hip flexion test position.
- We hypothesize that the 45° of hip flexion test position is likely to place maximal stress on the adductor musculature and the medial and anterior pelvic rings.
- A commercially available sphygmomanometer for the measurement of adductor squeeze values could aid clinicians in monitoring athletes' responses to treatment strategies used during rehabilitation for groin pain.

Chronic groin pain is a common problem among athletes, and approximately 5% of all soccer injuries are estimated[1] to affect the groin. The multifactorial nature of, and the various anatomical structures that contribute to, groin pain have made the condition difficult to prevent and manage. The development of groin pain in athletes has previously been shown[2,3] to be related to the strength of the adductor muscles. Furthermore, athletes who endure a large number of side-to-side movements, repetitive twisting and kicking, and rapid changes of direction appear to be most at risk of developing groin pain.[4–6] An adductor muscle–strengthening program comprises an effective strategy for reducing the incidence of groin pain in athletes.[2]

Gaelic Games are the traditional sports played in Ireland, the most popular being Gaelic football and hurling. Both are collision-contact sports with speed, strength, and agility demands similar to those of Australian rules football, rugby union and rugby league, field hockey, and lacrosse. These games are played at high speed, which, when combined with significant physical contact, acceleration, deceleration, and turning, has been proposed[7] to increase the likelihood of injury during the season. Newell et al[8] demonstrated that 65% of Gaelic football intercounty players were unable to fully participate in training/games for 1 to 3 weeks in a typical season as a result of injury.

O'Donoghue and King[9] investigated the high-intensity work-to-rest ratios in Gaelic Games by coding 55 players dur-

ing senior intervarsity matches. High-intensity activities were classified as running, sprinting, shuffling, and game-related activity (eg, kicking, passing, aerial challenging). On average, high-intensity work bouts lasted 5.7 seconds each and cumulatively accounted for 14% of actual game time. In a prospective study, Wilson et al[7] showed that 71.1% of injuries in Gaelic Games football players involved the lower limb, with groin injury being one of the most commonly encountered conditions.

Anatomical structures such as the adductor musculature and pubic symphysis are associated with groin pain; thus, researchers have described various pain-provocation tests for assessment. The pubic symphysis gap test was described by Rodriguez et al[10]: the patient is placed in 90° of hip and knee flexion and asked to squeeze the knees against the examiner's clenched fist. The squeeze test, described by Verrall et al,[11] requires the patient to squeeze the fist of the examiner, which is placed between the patient's knees with the hip joint in 45° of flexion and the feet resting on a plinth. A test in which the hip and knee joints are in neutral position has been described by Hölmich et al[12] and essentially consists of an isometric adduction against the examiner's fist, with the athlete lying supine. However, these tests are fundamentally similar, regardless of hip position or the object placed between the patient's knees, in that the individual squeezes both adductors of each leg; pain in the groin region constitutes a positive test. Thus, all 3 test positions (0°, 45°, and 90°) are commonly used in the clinical assessment of groin pain, and the patient is asked to maximally contract both sets of adductor muscles simultaneously or to essentially "squeeze the fist." The test is considered positive if the individual complains of pain in the adductor muscles or the bony structures of the anterior and medial pelvic ring. For the purpose of this article, we will use the generic term *adductor squeeze test* while specifying the associated hip-joint–flexion position.

Although the aforementioned studies describe isometric adductor activation in various hip flexion positions, the functional contribution of the adductor musculature in activities such as linear running indicates a more expansive role than simple frontal-plane motion. Dostal et al[13] noted that the adductor muscle group assists in sagittal-plane hip motion. The adductor magnus, regardless of hip position, assists the hamstrings and gluteus maximus in hip extension. Furthermore, hip flexion of more than 60° places the adductor longus in an orientation that is posterior to its axis of rotation, thereby assisting in hip extension, whereas hip flexion of less than 60° places the adductor longus in a position that is anterior to its axis of rotation, thereby producing a flexion moment arm.[14] This multifunctional role of the adductor muscle group provides the clinical rationale for adductor squeeze tests in varied positions and may also offer a basis for designing more functional tests to stress the adductor musculature.

Authors[15,16] of 2 recently published studies have quantified adductor strength during the adductor squeeze test with a handheld dynamometer and sphygmomanometer. Participants in these investigations were drawn from the Australian rules football and soccer populations. To date, no references in the literature have addressed reliability of the adductor squeeze test using a sphygmomanometer to assess adductor muscle integrity of Gaelic games athletes. Because of the high proportion of groin pain encountered in Gaelic games athletes, it is necessary to establish the reliability of the adductor squeeze test to allow clinicians to both monitor injury responses and assess return-to-play criteria.

Thus, the aims of our study were to determine (1) the intrarater reliability of the adductor squeeze test using a commercially available sphygmomanometer and (2) if any differences exist in the squeeze values (pressure values recorded on the sphygmomanometer dial) observed in the 3 test positions.

METHODS

Participants

Eighteen male Gaelic Games players (age = 21.11 ± 2.53 years, height = 1.78 ± 0.06 m, mass = 78.24 ± 11.76 kg) volunteered for the study. Participant recruitment was undertaken by placing notices on the University Sports Centre notice board. Inclusion criteria were as follows: (1) male, (2) currently playing Gaelic Games football or hurling, (3) no previous or current history of groin pain in either limb, (4) no previous or current history of pelvic pain, and (5) no other lower limb injury in the previous 6 months. Two of the investigators assessed the inclusion criteria for each participant via direct interview. The study was granted ethical approval by the University Human Research Ethics Committee, and before testing, each participant read an information leaflet and signed an informed consent.

Procedures

All testing was undertaken in a university clinical skills laboratory. Each participant visited the laboratory on 2 occasions, with visits separated by at least 1 week. Upon arriving at the laboratory for the first testing session, each participant was informed of the testing procedures and allowed 3 submaximal practice trials in each test position for familiarization with the protocol. All testing was supervised by a physiotherapist with 7 years of postqualification experience.

During testing, participants were positioned supine with their arms crossed and their heads flat on a plinth (Figures 1 through 3). Participants wore shorts during the testing session and were barefoot while lying on the plinth. For each session, participants were required to perform 3 maximum trials each of the adductor squeeze test in 0°, 45°, and 90° of hip flexion. The position of hip-joint flexion was measured and verified by 2 investigators using a goniometer. Furthermore, the hip joints were kept in neutral rotation in each of the test positions. The order of test position was randomized using a concealed-envelope procedure. The squeeze test was quantified using a sphygmomanometer (Disytest; Welch Allyn, Skaneateles, NY) that was preinflated to 10 mm Hg. The cuff of the sphygmomanometer was placed between the participant's knees, and he was instructed to squeeze the cuff as hard as he could. Specific emphasis was placed on correct positioning of the sphygmomanometer, such that the middle third of the cuff was located at the most prominent point of the medial femoral condyles. Before each squeeze test, the sphygmomanometer was allowed to settle for a period of 30 seconds (according to the manufacturer's recommendations); room temperature was monitored and kept constant across testing sessions. The highest pressure (squeeze) value displayed on the sphygmomanometer dial was recorded during each maximal adductor squeeze test. As noted in Figures 1 through 3, the participants were unable to see the sphygmomanometer dial during the testing session. They were allowed 2 minutes of rest between performances of the maximal squeeze test at each position.

Figure 1. The adductor squeeze test at 0° of hip flexion using a commercially available sphygmomanometer.

Figure 2. The adductor squeeze test at 45° of hip flexion using a commercially available sphygmomanometer.

Statistical Analysis

The sample size for the study was based on the methods described by Walter et al.[17] For the values $\varrho_0 = 0.5$, $\varrho_1 = 0.8$, $\alpha = .05$, and $\beta = .2$, a sample size of 15 was necessary. The average of 3 trials for each test position was used for statistical analysis. Intraclass correlation coefficients (ICCs) and 95% confidence intervals (CIs) were calculated to determine intrarater reliability. We chose the ICC (3,1) model, which corresponds to a 2-way mixed model, with single-measure reliability and absolute agreement calculated via SPSS (version 15.0; SPSS Inc, Chicago, IL). Reliability was judged based on established criteria: >0.75, excellent reliability; 0.60 to 0.74, good reliability; 0.40 to 0.59, fair reliability; and <0.40, poor reliability.[18]

Figure 3. The adductor squeeze test at 90° of hip flexion using a commercially available sphygmomanometer.

Furthermore, we calculated the standard error of measurement (SEM; according to the equations published by Weir[19]), the SEM percentage, and the minimal detectable change. Repeated-measures analysis of variance was used to test for differences in the values obtained during each of the test positions (0°, 45°, and 90°). When a main effect was observed, a Bonferroni adjusted pairwise comparison was undertaken. Values for η^2_p are included as indicators of effect sizes using analysis of variance.

RESULTS

Intrarater reliability (ICC values) ranged from 0.89 (95% CI = 0.74, 0.96) at 0° of hip flexion to 0.92 (95% CI = 0.82, 0.97) at 45° of hip flexion, thus indicating excellent reliability in all test positions (Table 1). The smallest amount of measurement error was seen at the 45° of hip flexion test position (SEM = 1.60%), compared with the 0° (SEM = 3.27%) and 90° (SEM = 2.21%) positions.

Mean squeeze values for each of the 3 test positions on days 1 and 2 of testing are shown in Table 2. A statistically significant effect was found for the 45° of hip flexion test position. Higher values were obtained in this test position compared with the 0° ($P < .01$) and 90° ($P < .01$) positions on day 1 and with the 0° ($P < .05$) and 90° ($P < .01$) positions on day 2. The η^2_p values were 0.78 on day 1 and 0.82 on day 2, indicating strong effect sizes.

DISCUSSION

Groin pain is a frequently encountered clinical entity in Gaelic Games athletes.[7] To our knowledge, no authors to date have investigated the intrarater reliability of the adductor squeeze test in asymptomatic Gaelic Games athletes using a

Table 1. Intraclass Correlation Coefficient Estimates for the Adductor Squeeze Test Using a Sphygmomanometer

Hip flexion Test Position, °	Intraclass Correlation Coefficient (3,1)	95% Confidence Interval	Standard Error of Measurement, mm Hg	Standard Error of Measurement, %	Minimal Detectable Change
0	0.89	0.74, 0.96	6.75	3.27	18.71
45	0.92	0.82, 0.97	3.83	1.60	10.62
90	0.90	0.66, 0.97	4.23	2.21	11.73

Table 2. Adductor Squeeze Values for 3 Test Positions on Days 1 and 2

	Adductor Squeeze Value, mm Hg (Mean ± SD)			
	0°	45°	90°	η_p^2
Day 1	202.50 ± 57.28	236.76 ± 47.29[a,b]	186.11 ± 44.01	0.78
Day 2	210.18 ± 61.73	241.48 ± 48.91[a,b]	196.94 ± 39.84	0.82

[a] Different from 0°.

[b] Different from 90°.

commercially available sphygmomanometer. Thus, we are the first to investigate this issue and to analyze the differences in squeeze values across the 3 test positions.

The ICC values calculated for each of the test positions demonstrated excellent reliability, with values of 0.89, 0.92, and 0.90 for the 0°, 45°, and 90° of hip flexion test positions, respectively. These results concur with those of Fulcher et al[15] and Malliaras et al.[16] Malliaras et al[16] used a commercially available sphygmomanometer to examine squeeze test values in elite junior Australian rules football and soccer players. They obtained ICC values for the 0°, 30°, and 45° hip flexion test positions of 0.81, 0.91, and 0.94, respectively. We also tested 0° and 45° of hip flexion and found ICC values of 0.89 and 0.92, respectively. Furthermore, the squeeze values we observed are somewhat comparable to those of Malliaras et al,[16] who reported 210.8 ± 39.3 mm Hg in the 0° of hip flexion test position and 209.6 ± 42.3 mm Hg in the 45° of hip flexion test position. Fulcher et al[15] quantified adductor strength in male semiprofessional soccer players in the test positions of 0°, 45°, and 90° of hip flexion using a handheld dynamometer. Their ICC values were 0.85, 0.77, and 0.87, respectively, which are consistent with the ICC values we obtained.

In addition to computing ICC values, we also undertook statistical analysis to determine if maximum squeeze values differed among the 3 test positions. On both days, the mean squeeze value was higher at 45° of hip flexion than at 0° and 90° of hip flexion (Table 2). Additionally, η_p^2 values for day 1 and day 2 were 0.78 and 0.82, respectively, indicating strong effect sizes. Given that the 45° of hip flexion test position was associated with the greatest squeeze value, the greatest stress on the adductor musculature and pubic bone during the adductor squeeze test is likely to occur in this testing position. For this reason, we believe that when assessing both groin pain and adductor squeeze values, 45° of hip flexion is the optimal testing position. To confirm our hypothesis, further testing is required to determine electromyographic activity of the adductor longus muscle at the different positions of hip-joint flexion.

The present study does have a number of points worth noting. All participants were free from groin pain, according to the aforementioned inclusion criteria, and, therefore, there were no confounding issues stemming from a previous history of groin pain. This factor is in contrast to the studies of Fulcher et al[15] and Malliaras et al.[16] Fulcher et al[15] found that 30% of participants reported a degree of groin discomfort during the testing. Furthermore, 70% of participants reported a previous history of groin pain.

Test-retest methods are criticized by many researchers as a method of gauging reliability. Among the difficulties associated with these methods is the fact that short intervals between administrations of the instrument can yield reliability estimates that are too high. In our study, the interval between test and retest was a minimum of 7 days (mean = 9 days). In previous studies,[15,16] retesting was carried out during the same session. We believe that our testing protocol better simulates the process of assessing and monitoring athletes in a clinical environment. Furthermore, in our study, for the retest session, the examiner was blinded to the initial test session results, which reduced the risk of reporting bias.

Early detection and intervention are the keys to optimal management and prevention of chronic injury. The current lack of reliable clinical indicators (ie, clinical and functional screening tests) to assess the likelihood of developing chronic groin pain makes it difficult to establish effective prophylactic strategies.[20] For the adductor squeeze test, 45° of hip flexion was the best testing position. No participants had groin pain; hence, a true picture of normative data in a healthy population is provided. We found excellent intrarater reliability for measuring adductor squeeze values using a sphygmomanometer in healthy male Gaelic Games athletes. We propose that a commercially available sphygmomanometer is a cost-effective method of assessing adductor squeeze values in clinical practice. It allows for the objective measurement of adductor squeeze values, which could be readily used by clinicians to monitor potential injury risk, advance rehabilitation, and determine suitability for return to sport participation.

Future studies are now warranted to determine the predictive power of the adductor squeeze test in identifying athletes at risk of developing groin pain. This question could be answered by a prospective study, with regular testing of squeeze values across the course of an athletic season. Also, the interrater reliability of the adductor squeeze test needs to be established in Gaelic Games athletes. In addition, investigators should concentrate on the acquisition of squeeze values in athletes with acute and chronic groin pain.

CONCLUSIONS

A commercially available sphygmomanometer is a reliable tool for assessing adductor squeeze values in Gaelic Games athletes. Furthermore, our results indicate that 45° of hip flexion may represent the optimal test position for the adductor squeeze test.

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