

# STRENGTH MEASUREMENTS IN ATHLETES WITH GROIN PAIN

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## INTRODUCTION

Hip and groin pain is a common problem often related to physical functioning and sports activities. Groin pain has been particularly reported in sports such as football and ice hockey, where approximately 10 to 20% of all injuries are hip and/or groin injuries. Assessment of hip muscle strength plays an important role in the clinical assessment of the hip and groin region in athletes and clinical methods that can quantify muscle strength around the hip are necessary. Decreased muscle strength seems to be a recurring problem in athletes with hip and groin pathology. In a randomised, controlled clinical trial by Hölmich et al<sup>4</sup>, including patients with long-standing adductor-related groin pain, greater increase in isometric hip adduction muscle strength was documented in

patients treated with an active treatment approach than patients treated with a passive approach. The active treatment approach was an exercise programme aimed at improving co-ordination and strength of the stabilising muscles of the pelvis and hip joints, especially the adductors. Furthermore, reduced hip adduction strength in football and hockey players, isometric and eccentric, seem to be related to an increased risk of sustaining a future groin injury.

## MUSCLE STRENGTH TESTING

Muscle strength refers to the amount of force a muscle can produce with a single maximal effort. Both the size of muscle cells (the contractile component) and the ability of nerves to activate them (the neural component) are related to muscle strength.

Concentric muscle action occurs when the muscle shortens and joint movement occurs as tension develops. Eccentric muscle action occurs when external resistance exceeds muscle force and the muscle tendon unit lengthens while developing tension. Isometric muscle action occurs when a muscle generates force and attempts to shorten but cannot overcome the external resistance. Traditionally, manual muscle testing (MMT) has been used in the clinical assessment of hip muscle strength. MMT evaluates muscle strength from 0 to 5 and defines the 6 levels as:

- 0 (Gone) - no contraction felt.
- 1 (Trace) - muscle can be felt to tighten, but cannot produce movement.
- 2 (Poor) - produces movement with gravity eliminated, but cannot function against gravity.

- 3 (Fair) - can raise part against gravity.
- 4 (Good) - can raise part against outside resistance as well as against gravity.
- 5 (Normal) - can overcome a greater amount of resistance than 'good' muscle.

The advantage of MMT is that no equipment is needed and the procedure is easy and quick to use. However, MMT has certain limitations when testing patients stronger than level 3. Most physically active patients, with no severe disability, score level 5 in MMT, despite having muscular deficits. Previously it has been shown that muscle-strength deficits up to 50%, assessed by quantitative measurement methods (dynamometer), are not identified by MMT. In physically active patients with long-standing groin pain, a manual assessment method of hip adduction and hip flexion has been proposed by Hölmich et al<sup>3</sup>. This method divides muscle strength into one of three levels: weak, intermediate and strong. Kappa values of the intra-observer reliability of this procedure ranged from 0.58 to 0.72 and the kappa values of the inter-observer reliability ranged from 0 to 0.22, indicating that this procedure is not reliable between testers.

#### NEW METHODS FOR CLINICAL STRENGTH TESTING

New clinical testing procedures, such as the squeeze test and strength testing using hand-held dynamometers (HHD),



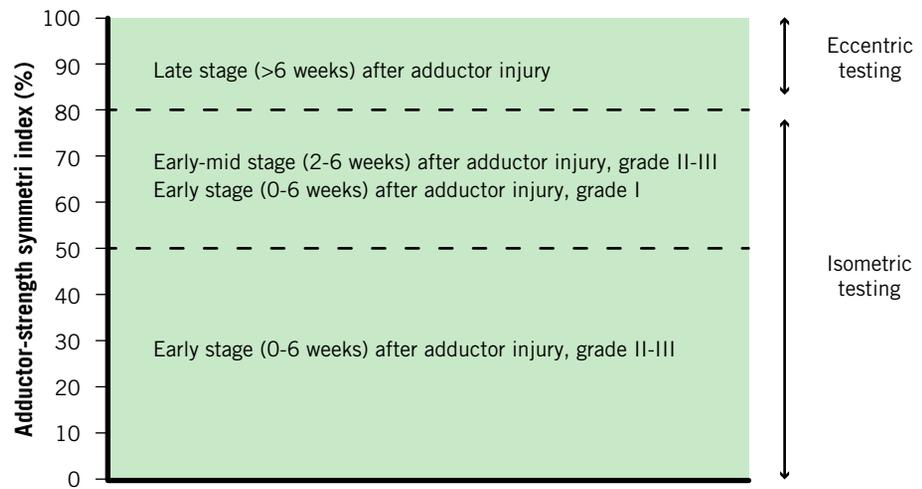
have recently been introduced for athletes with hip and groin pain. The squeeze test is quantified by using the cuff of a sphygmomanometer, which is placed between the knees and the athletes are then instructed to squeeze the cuff as hard as they can using both legs. The highest pressure displayed on the sphygmomanometer dial (to the nearest 5 mmHg) during the test is then recorded. While the reliability of the squeeze test is high, the validity for the squeeze test, using the sphygmomanometer, as a measure of muscle strength has not been investigated. The HHD is a quantitative measurement method for assessing unilateral muscle strength that has been used since the 1940s. It is a portable measurement device and it has previously been used for assessing hip

muscle strength in other patient groups. The procedure is inexpensive and easy to administer, which makes it suitable for the clinical setting. When measuring muscle strength the SI unit (system of international units) for force is the Newton. To express maximal torque, force is multiplied by the moment arm to get the SI unit Newton meter (Nm). The moment arm is the distance from the axis of rotation to the application centre of the load cell of the dynamometer. Nm is then normalised to bodyweight to get the maximal torque per kilogram of bodyweight (Nm/kg bodyweight). This is often referred to as muscle strength. In this way, the influence of differences in body weight and limb lengths, known to have an isolated effect on muscle strength, can be controlled for.

HHD is a valid measure of muscle strength, but different factors have been shown to influence the reliability of HHD when assessing muscle strength. Mechanically, HHD is reliable and the experienced tester will produce good intra-tester reliability. However, if the strength of the person being tested exceeds the tester's strength, reliability is compromised. Furthermore, the testing position and the lever arm used for testing also seem to influence the reliability of the procedure. The reliability between make and break tests has been investigated in different studies with conflicting results. For hip adduction we found substantial intra-tester reliability for both isometric and eccentric testing with Intraclass Correlation Coefficients  $>0.90$ , with no systematic error between tests and individual measurement variation of less than 10%. Inter-tester reliability is not as good as intra-tester reliability, but adequate values can be obtained with skilled testers. If testers are not able to provide sufficient resistance for the isometric test a belt can be used for external support, which improves reliability (precision) and validity (accuracy) of the measurements. Eccentric strength testing has shown greater strength values than isometric testing, but a high correlation exists between the two types of tests (contraction types) and more than 65% of the variance produced by one type of test can be explained by the force produced during the other type of test. This means that the isometric and eccentric test presumably measure a similar construct (maximal voluntary strength), under different conditions (contraction forms).

**Eccentric hip adduction symmetry cannot be assumed in injury-free soccer players**

### Hip adduction strength testing



**Figure 1:** Theoretical illustration of adductor-strength symmetry indexes in different adductor injuries and injury stages. Suggestions for relevant type of strength measures (contraction forms).

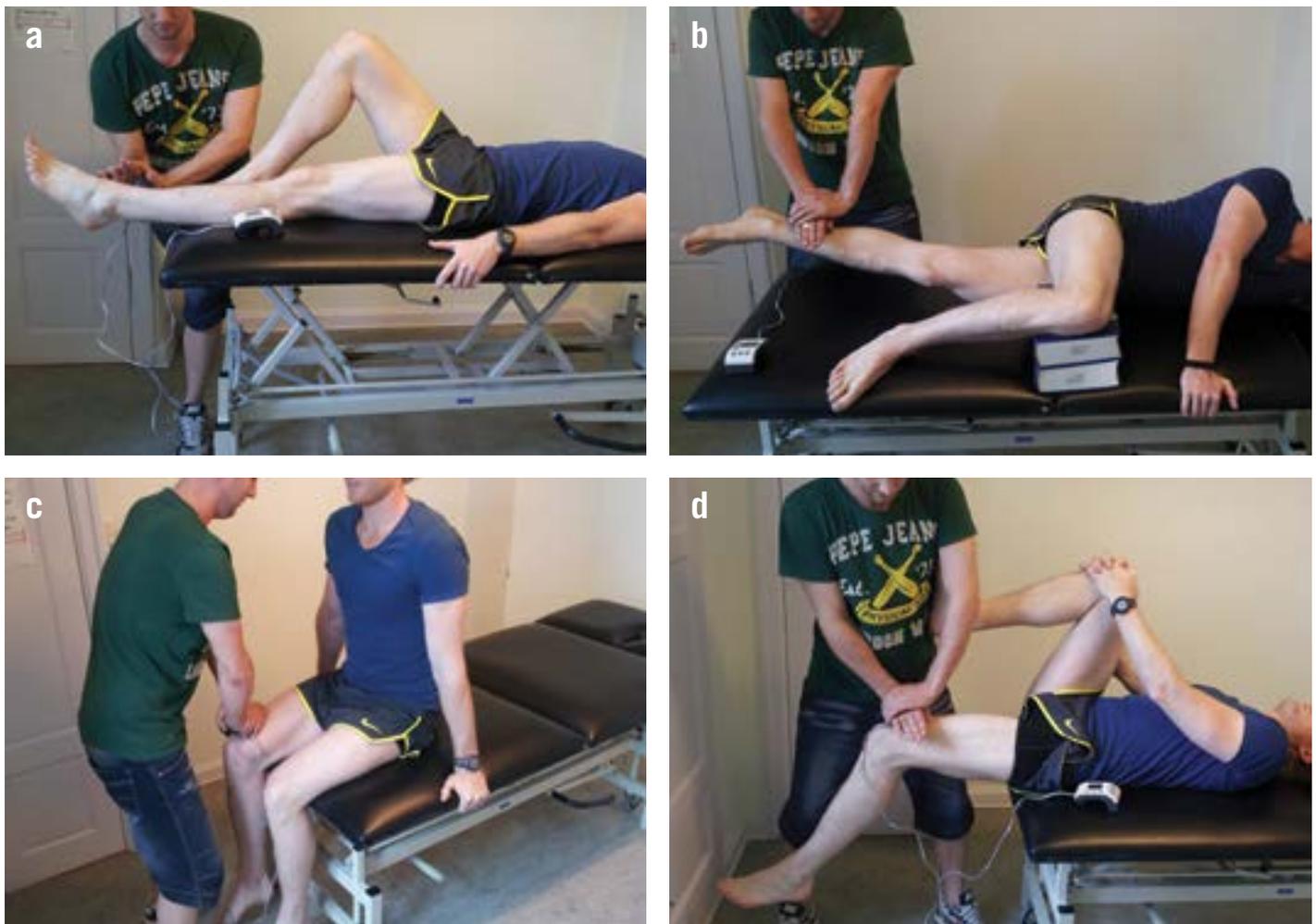
### CLINICAL REASONING WHEN CHOOSING A SPECIFIC STRENGTH TEST

Strength tests have clinical advantages and disadvantages that should be considered before use. An advantage of the isometric test is that isometric loading induces less stress to the musculoskeletal system than eccentric loading, thus minimising the risk of injury and delayed-onset muscle soreness. In situations in clinical practice where eccentric testing is not feasible due to the pathological state of the athletes, isometric testing should be preferred (Figure 1). Strength data obtained by HHD can be used clinically in different ways. One possibility is to use normative values. However, normative values often do not exist for different age groups and levels of physical activity and is therefore rarely an option. Another possibility is to use the unaffected limb as a control. A lower limb symmetry index can then be calculated by dividing the strength of the affected limb by the unaffected limb (Figure 1).

Generally, it has been suggested that lower-extremity strength deficits of less than 10% on the injured side compared to the uninjured side should be considered the clinical milestone before returning an athlete to sport following injury. More specifically, the achievement of a hip adduction/abduction ratio of more than 90% and hip adduction strength equal to that of the contralateral side has been

recommended before returning to sport after an adductor strain. However, we have previously shown that eccentric hip adduction symmetry cannot be assumed in injury-free soccer players. In fact, the dominant side was 14% stronger than the non-dominant side with regards to eccentric hip adduction strength. This finding of asymmetric eccentric hip adduction strength in injury-free soccer players, between the dominant and non-dominant leg, indicates that using contralateral eccentric hip adduction strength as a reference-point for muscle recovery may be questionable. Strength ratios such as the hip adduction/abduction strength ratio have previously been used for research purposes and seem to be a relevant measure of hip strength, especially in athletes with bilateral groin symptoms, where the contralateral limb cannot be used as a reference point. For clinical evaluation of the individual athlete, the obvious advantage is that this testing method does not require any age, limb-length or weight adjustment, since the player can act as his own control. This makes the testing method ideal for quick assessments in the busy clinical situation. In addition, measurement of muscle strength in a supine starting position provides an advantage in the assessment of isometric hip adduction and abduction strength as it can be used in people who are either unable or have great difficulty by producing sufficient

1	2	3	4	5	6	7	8	9	10	NRS	1	2	3	4	5	6	7	8	9	10
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1	2	3	4	5	6	7	8	9	10	NRS	1	2	3	4	5	6	7	8	9	10
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**Figure 2:** Median pain values, as rated by soccer players with long-standing adductor-related groin pain, during different unilateral hip strength tests. Numerical Pain Rating Scale (NRS). a) Isometric hip adduction, b) eccentric hip adduction, c) isometric hip flexion ( $^{\circ}90$ ), d) isometric hip flexion (modified Thomas test/pubis symphysis stress test). Original and standardised testing protocols of these measures are present in reference 9 for measure a) and c), reference 10 for measure b) and reference 13 for measure d).

power (acute and severe injuries) in the side-lying position to overcome the force of gravity, as a result of either muscle weakness or pain. The use of isometric hip adduction strength as a clinical reference point for the achievement of full hip adduction muscle strength in soccer players, for example, gives the clinician an opportunity to precisely quantify hip muscle strength and thus detect specific weaknesses in the hip muscles. This is relevant for the planning and monitoring of an individual rehabilitation programme and increases the possibility to bring players back without them still having reduced hip muscle strength. In the future, HHD measures may be an important tool when attempting to minimise the risk of re-injury,

which is a major problem for footballers with hip and/or groin injuries.

#### STRENGTH MEASUREMENTS IN ATHLETES WITH GROIN INJURY IN RELATION TO RETURN TO PLAY

In athletes with unspecific groin and adductor-related pain, it seems that bilateral isometric hip adductor strength is decreased by 20 to 25% compared with asymptomatic controls when using a sphygmomanometer in the squeeze test. These studies use a bilateral adduction testing approach where the squeeze output will be determined by the weaker side. This also means that there is no side available for comparison, making it impossible to determine when

muscle strength is fully recovered after injury when using this test, unless baseline values before time of the injury have been established. Furthermore, the squeeze test is often performed in different degrees of hip-flexion (30, 45 and 90 degrees) possibly including a considerable force contribution from both hip adductors and hip internal rotators. The squeeze test may, therefore, not necessarily correspond to unilateral hip adduction strength performance. In a recent study using unilateral strength testing by HHD we observed no isometric strength deficits but only eccentric strength deficits in soccer players with adductor-related groin pain compared to asymptomatic soccer controls.

It is unclear how pain of a more long-standing nature affects muscle strength. We therefore reported subjective pain levels on a numerical pain rating scale (NRS) from 0 to 10, during hip strength testing (Figure 2), in order to investigate whether possible differences in hip strength could be related to differences in pain levels during testing. The results of our study suggest that pain during testing was not related to weakness, as no significant correlation existed between hip strength and pain during strength testing. We assume that pain may play a more pertinent role when testing more acute hip and groin injuries, but we believe that strength testing under safe conditions (isometric before eccentric) is still important to apply both after acute and more long-standing injuries. The reason for this is that the mechanical force output produced by these athletes during maximal strength testing will also be reflected in the amount of force that these athletes are able to produce in relevant maximal athletic activities that involve specific hip muscles, such as the hip flexors and the adductors. In this way unilateral hip muscle strength testing provides a good indication of the ability of the athlete to generate maximum forces of e.g. the adductors, during different contraction forms, isometric as well as eccentric, in important specific athletic skills such as kicking, accelerating, decelerating, cutting movements, fast speed running etc. When the athlete can generate sufficient hip adduction forces comparable to that of the healthy side and/or to the abductors under the following conditions:

1. isometrically and eccentrically and
2. without or with only minimal pain (NRS=0-2),

then more strenuous sports-specific athletic activities and return to play test batteries can be commenced in a more comprehensive, yet safer, manner.

## CONCLUSION

Many different ways of clinically assessing hip strength in athletes exist today. Substantial reliability and good discriminative validity exist for both unilateral hip strength tests and for the squeeze test. These tests are therefore recommended for both clinical and research purposes. Early investigations indicate that

unilateral strength measurements can be considered to be relevant to include in the monitoring of rehabilitation and in the return to play process for athletes with groin injury, but more research is needed in this area.

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