RELIABILITY AND BILATERAL STRENGTH IMBALANCES OF A NEW ISOMETRIC TEST TO IDENTIFY PREVIOUS HAMSTRING STRAIN COMPARED TO ECCENTRIC STRENGTH

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The purpose of this study was to investigate the reliability of a novel device in assessing isometric hamstring strength and determine whether isometric and eccentric strength imbalances remain in previously injured Gaelic footballers from the previous season. A total of 70 amateur Gaelic Footballers were tested in the preseason period (January to March 2020) and 45 of these players were tested on two separate occasions no more than 7 days apart to determine the test-retest reliability of the new Isometric hamstring strength assessment approach. The Nordic hamstring exercise was used to determine maximal hamstring eccentric Torque using the Nordbord testing system™. The isometric testing showed a moderate to high reliability ICC (CI 95%) of 0.89 (CI 0.79-0.94) with the typical error of 7.7 % (6.9-9.7%). Those with previous HSI had significantly lower Isometric strength for the involved side when comparing to the non-involved side in terms of Absolute force, Relative force, Absolute Torque, Relative torque ($p<0.01$, $d=0.68-0.74$) whereas there was no differences evident in eccentric strength. A novel approach to isometric strength testing demonstrates moderate to high reliability and identifies bilateral deficits remain following HSI in the previous season and may help explain the high recurrence rate within the sport.

KEYWORDS: strength assessment, torque, novel, isometric

INTRODUCTION: Gaelic football (GF) is one of Ireland's leading national sports and is characterized as being multidirectional in nature with bouts of high intensity and velocity running (McIntyre 2005). Injury is commonplace, with teams typically sustaining an average of nine Hamstring strain injuries (HSI's) per year with an average time loss of 26 days (Roe et al., 2018). The incidence of HSI in Gaelic football is higher than soccer (2.2 injuries per 1000hours) and the issue is not improving with a twofold increase in HSI from 2008/2011 (1.9 injuries per 1000 hours) to 2012/2015 (3.9 injuries per 1000 hours) (Roe *et al.* 2016). It has previously been reported that eccentric strength testing does not distinguish players who have previously suffered HSI in Gaelic football (Mc Intyre et al., 2020) and this has also been advocated in professional football players (Opar et al., 2015; Van Dyk et al., 2017). The breaking point or angle of peak torque measurement being responsible. A more novel approach in which the position of testing is more similar to the mechanism of injury in late swing/early stance may provide more sensitivity in detecting residual deficits. The purpose of this study was determine the test-retest reliability of a novel isometric method assessing hamstring knee flexor strength and to determine if any differences exist in isometric and eccentric hamstring strength in previously injured and un-injured players during pre-season screening.

METHODS: A total of 70 players were tested in the pre-season period (January to March 2020) and 45 of these players were re-tested (no more than 7 days apart) to determine the test-retest reliability of the new Isometric hamstring strength assessment approach. Bilateral Isometric strength was assessed via two load cells attached at the ankles, where the subject was seated (30cm from the pad), the knees were placed against the vertical upright and seat height modified to attain 150^0 of knee extension measured by a goniometer. The test was then administered for 10 seconds repeated 3 times and the maximum force recorded. Following 3 mins of inactive recovery the Nordic hamstring exercise was used to determine maximal hamstring eccentric torque (Opar *et al*, 2013). Data was analysed using SPSS software package V.18.0 (SPSS Inc, Chicago, Illinois, USA). An Interclass correlation coefficient test was performed to determine reliability (Vincent, 2005).

RESULTS: The isometric testing showed a moderate to high reliability ICC (CI 95%) of 0.89 (CI 0.79-0.94) in terms of peak force (N). The typical error of which was 7.7 % (6.9-9.7%).

Table 1. Test-retest reliability for isometric knee flexion peak force (Newtons) (n=45).

Load Cell	Test 1	Test 2	Effect size	ICC (CI 95%)	Typical Error	Typical Error (%)
Left leg	327±56	337±63	-0.08	0.87 (0.77-0.93)	28.4 (23.5-35.9)	8.6 (7.1-10.8)
Right leg	328±55	333±66	-0.04	0.88 (0.79- 0.94)	28.0 (23.2-35.3)	8.5 (7.0-10.7)
Mean of left and right	328±51	336±60	-0.07	0.89 (0.79-.0.94)	25.41 (21.0-32.1)	7.7 (6.4-9.7)

18 out of 70 participants sustained a total of 21 hamstring strains (3 were recurrent), in the season prior to testing. In the previously injured group in pre-season there was a significant difference between the involved and uninvolved sides in Absolute force, Relative force, Absolute Torque. Relative torque and Scaled force measures ($p<0.01$, $d=0.68$-0.74) for isometric strength but no differences in terms of eccentric strength (Table 2).

Table 2. Previously injured group eccentric and isometric hamstring variables.

	Eccentric			Isometric		
Limb	**Involved**	**Non-Involved**	**Effect size**	**Involved**	**Non-Involved**	**Effect size**
Absolute Force (N)	307±64	322±64	0.234	281±66	332±72**	0.738
Relative force (N.kg)	3.81±1.07	3.98±1.02	0.162	3.48±0.89	4.11±0.92**	0.696
Absolute Torque (Nm)	136±34	143±33	0.209	120±29	142±31**	0.72
Relative Torque (Nm.kg)	1.68±.49	1.75±.45	0.149	1.49±.39	1.76±.40**	0.683

*Significant difference P>0.05 ** Significant difference P>0.01

DISCUSSION: The findings from this study indicated moderate to high reliability for our novel isometric testing and we found that in previously injured footballers there was an underlying isometric bilateral strength imbalance between uninjured and previously injured legs, whereas eccentric strength imbalances were not evident.

Our ICC reliability of 0.89, was similar to other hamstring isometric strength testing for both an externally fixed dynamometer (ICC 0.74-0.93) (Wollin et al., 2015) and apparatus using a force platform (ICC=0.86-0.95) (Mc Call et al. 2015). Isometric strength can be determined using the current system, test protocols and procedures reliably to assess knee flexor isometric strength.

A case study has reported maximum voluntary isometric contraction (MVIC) to identify a player susceptible to hamstring strain (Schache et al. 2011). This was undertaken in a prone position at 90^0 of knee flexion whereas we test in an upright posture at 150^0 of knee extension. We report Isometric hamstring force and torque all differed significantly with a moderate effect size between the injured and uninjured sides in players with previous hamstring injury. Interestingly players who had suffered HSI did not differ in terms of eccentric strength between the involved and un-involved sides and corroborates previous research that eccentric pre-season strength does not distinguish players who previously suffered HSI in Gaelic football (McIntyre et al. 2020; Roe et al. 2020). Previous injury is a strong risk factor (Opar *et al.,* 2015; Warren et al., 2010), on return to play a Gaelic footballer is 230% more likely to sustain a future injury compared to un-injured players (Roe et al., 2018) and previously injured Gaelic players are 33 times more likely to sustain an HSI (McIntyre et al. 2020). One would assume therefore, strength deficits to still exist and it maybe that, isometric testing is more sensitive to detecting residual or underlying weaknesses than the eccentric strength method. Some rehabilitation exercises (Straight knee bridge, upright hip extension, loaded leg curls) generate only between 40-85% MVIC (Hegi et al., 2019) and may be responsible for these underlying deficits which contribute to the high recurrence rate within the sport. The bilateral isometric test assesses muscle function in a long lever 150^0 position whereas the Nordbord fallout (does not test in this position as a break point angle has been reported to occur in high performers at 126 ± 6^0 and low performers 103 ± 7^0 (Ripley et al., 2020), at inner hamstring ranges. This is particularly relevant as running accounts for 89% of all injuries in this current study and there is a wide consensus, that HSI is likely to occur in either late swing phase or early stance (Chumanov et al., 2012) and generally occurs between $140\text{-}150^0$ of knee extension.The long lever testing position in which the bilateral isometric test places the hamstrings in a position similar to late swing/early stance may better simulate the mechanism of HSI and detect any underlying weaknesses. This may account for its greater sensitivity and explain the difference between the two tests.

CONCLUSION: We have demonstrated high reliability for this novel test of isometric hamstring strength. It appears to be more sensitive at identifying residual weakness in previously injured players than current eccentric assessments, and hence has the potential to improve our identification of players at risk of HSI.

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