RELIABILITY OF PASSIVE LOWER LIMB FLEXIBILITY IN RUGBY SEVENS PLAYERS MEASURED WITH A NEW HAND HELD DYNAMOMETER: A PILOT STUDY

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This study assessed the within-day reliability of five passive lower extremity flexibility measures using a unique hand held dynamometer (HHD) that simultaneously detects dynamic force applied via a force pad and alteration in orientation in space between start and end points of range of motion via a tilt sensor. Hip extensor flexibility in the passive straight leg raise, hip internal and external rotation and hip flexion in two Modified Thomas test positions were conducted on 21 elite male athletes from a rugby sevens training squad using the HHD. There was very good to excellent within-day reliability for the flexibility measures ICC 0.79-0.96 and standardised typical error 0.21-0.48. The HHD facilitated a consistent applied force across trials for each player helping to provide high within-day reliability for the flexibility measures.

KEY WORDS: flexibility, reliability, rugby, range of motion, force.

INTRODUCTION: Lower limb flexibility variables, such as hamstring flexibility, have been associated with rugby-related injuries. However, few studies have determined the reliability of such variables for elite athletes. Reliability is considered synonymous with the consistency of a measurement (Atkinson & Nevill, 1998) and needs to be determined before the measurement can be used longitudinally to evaluate the value of flexibility training and any link between flexibility and performance can be made. Although assessments of the reliability of the flexibility tests to be used in this study have previously been performed (Hartman & Looney, 2003; Gabbe , Bennell, Wajswelner, & Finch, 2004, Peeler & Anderson, 2007, Clapis, Davis, & Davis, 2008, Peeler & Anderson, 2008, Malliaras, Hogan, Nawrocki, Crossley, & Schache, 2009, Bozic, Pazin, Berjan, Planic, & Cuk, 2010, Ferber, Kendall, & Mcelroy, 2010, Sporis, Vucetic, Jovanovic, Jukic, & Omrcen, 2011), to our knowledge none have been specific to the population to be used in this study, nor using the new hand held dynamometer (HHD).
The HHD is a new device under development that simultaneously detects dynamic force applied via a force pad (Industrial Research Limited, 2010) and alteration in orientation in space between start and end point of range of motion (ROM) in degrees via a tilt sensor (Industrial Research Limited, 2010). These features aim to facilitate maintaining a consistent applied force by the tester to the athlete during the passive flexibility tests. Reliability of passive flexibility measurements can change with the experience of the tester and the amount of passive force applied during the test, so the HHD could be a useful new tool to improve flexibility measurements.
The aim of this study was to determine the within-player reliability of five lower extremity flexibility tests for elite Rugby Sevens players using the HHD.

METHODS: Twenty one male elite rugby sevens players attending New Zealand Rugby Sevens squad trial/camps were measured for standing height, body mass, and leg length using the International Society for the Advancement of Kinanthropometry protocols (Marfell-Jones, Olds, Stewart, & Carter, 2006). All flexibility tests were conducted by a qualified physiotherapist with 15 years experience measuring joint ROM. Players did not complete a warm-up to be consistent with the usual testing procedures used by the physiotherapist for joint ROM testing during rugby squad training camps.

Passive ROM was measured using the HHD for hip internal rotation (IR) (Hollman, Burgess, & Bokermann, 2003), hip external rotation (ER) (Hollman et al., 2003) and hip flexion using the straight leg raise (SLR) (Gabbe, Bennell, Wajswelner, & Finch, 2004) and the Modified Thomas test (Upper limb) (TTU) (Harvey, 1998) and Modified Thomas test (Lower limb) (TTL) (Harvey, 1998). Test order was consistent between players: SLR, IR, ER, TTU and TTL. Both IR and ER were measured seated and SLR, TTU and TTL were measured supine. Each test was performed a minimum of three times on the right limb. The process was repeated on the left limb with the exception of ER which was performed on the left limb first to save time due to the examiner only needing to change sides twice. During each test the limb was held for three seconds at the end of ROM with the physiotherapist maintaining a consistent force readout from the HHD for each of the trials within a type of flexibility measurement.

For all variables intra-class correlation coefficients (ICC) were calculated as a measure of reliability (Hopkins, 2000a) according to the methods of Hopkins (2009). The present study interpreted an ICC of 0-0.1 as trivial, 0.1-0.3 as low, 0.3-0.5 as moderate, 0.5-0.7 as good, 0.7-0.9 as very good and 0.9-1 as excellent or practical (Hopkins, 2000b). Unbiased error and standardised typical error were also calculated according to the methods of Hopkins (2009). Standardised typical error was interpreted as an effect size using the scale 0-0.2 as trivial, 0.2-0.6 as small, 0.6-1.2 as moderate, 1.2-2 as large, 2.0-4.0 as very large and >4.0 as excellent (Hopkins, 2000b).

RESULTS: There was very good to excellent within-day reliability for lower extremity flexibility (within-day ICC 0.79-0.96) measures (Table 1 and Figure 1). The lowest ICC (0.79) was for TTU Right and the greatest ICC (0.96) for TTL Right. Half of the tests had ICCs greater than 0.9 (SLR Left and Right, TTL Left and Right and ER Right). Standardised typical error was interpreted as small (0.21-0.48) (Table 1).

Table 1: Within-day reliability of flexibility measurements for 21 Rugby Sevens players using the hand held dynamometer.

Passive end range of motion (degrees)		Mean ±SD	Within-day (ICC)	Standardised typical error (mean)
Passive straight leg raise	**Right**	92.2 ±10.9	0.92	0.29
	Left	92.1 ±9.3	0.93	0.28
Hip internal rotation	**Right**	36.3 ±5.4	0.87	0.38
	Left	36.5 ±5.9	0.89	0.36
Hip external rotation	**Right**	45.2 ±7.4	0.91	0.33
	Left	43.3 ±6.6	0.87	0.38
Thomas test- upper limb	**Right**	11.9 ±2.6	0.79	0.48
	Left	13.2 ±3.7	0.84	0.42
Thomas test- lower limb	**Right**	108.3 ±15.3	0.96	0.21
	Left	110.5 ±15.5	0.94	0.25

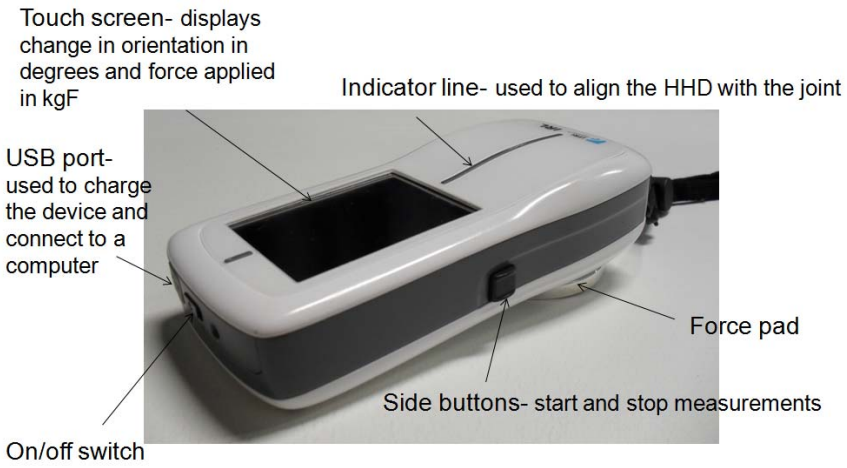

Figure 1: The visible features of the hand held dynamometer.

DISCUSSION: The very good to excellent within-day reliability and small standardised typical error of all of the passive flexibility tests supports their use with similar populations of athletes.

Hopkins (2000b) argued that correlations greater than 0.9 are necessary to consider a measure valid and practical. Half of the tests in this study had ICCs greater than 0.9. From the lower ICC value obtained for the TTU (0.79 and 0.84), compared with TTL (0.96 and 0.94) it may be interpreted that the lower limb version is more reliable and therefore its use more appealing. It could be argued that using the lower limb assessment, which measures the knee angle, is a more comprehensive assessment because the Rectus Femoris contributes to the movement as well as the Iliopsoas (Peeler and Anderson, 2007, Peeler and Anderson, 2008). The difference may be as a result of another examiner restraining the opposite limb of the player in TTL and not in TTU, allowing the physiotherapist with the HHD to concentrate all their efforts on the target limb. As with all the tests in this pilot study, further research would need to be conducted to examine inter-day reliability and inter-rater reliability. The tests in this study were conducted by a qualified physiotherapist with 15 years experience measuring joint ROM and it was recognized that this expertise helped produce the most consistent results using the HHD. Any inter-rater reliability results would likely be considerably affected if a less skilled individual were to perform the tests.

The HHD may be more expensive than other methods of assessing ROM such as video and software to digitise angles, or the cheaper but probably less reliable use of a plastic goniometer. The HHD may provide a more objective assessment than a simple pass/fail or negative/positive classification determined visually (Clapis et al., 2008, Peeler and Anderson, 2007), which is often used for the Thomas Test. The TTU and TTL ICC values (0.79-0.96) in this study were higher than the mean intrarater ICC values for pass/fail (0.4) and goniometer (0.67) methods in a study by Peeler and Andersen (2008). The SLR ICC values (0.92 and 0.93) were lower than the intratrial SLR ICC (0.97) in the study by Bozic et al. (2010), however the HHD is arguably more practical than outlining a protractor on an adjacent wall as per the methodology in the earlier study. A possible advantage of the HHD over a goniometer is the reduction in error that can potentially be caused by incorrect locating of the joint axis of rotation when using the goniometer (Clapis et al., 2008, Peeler and Anderson, 2007).

The practical outcome from this study is that the physiotherapist for the New Zealand Sevens is now using the HHD flexibility measurements as part of a screening process for athlete selection, and a study is underway to determine any links between flexibility and rugby performance. The flexibility data obtained is being used to prescribe individualised flexibility training programmes based on weaknesses observed from comparisons to normative values for the elite male rugby players reported in this pilot study. It is to be noted that the high standard deviations for the grouped data need to be considered when interpreting the “normative” values. Discrepancies between the scores for each limb can demonstrate an

imbalance in flexibility between limbs, which can also be addressed through training and may help to reduce injury risk.

CONCLUSION: This pilot study investigated the within-day reliability of five lower limb passive flexibility measures of elite male rugby players using a unique hand held dynamometer. The reliability of each flexibility test was deemed very good to excellent with the Passive straight leg raise and Modified Thomas test on the lower limb obtaining ICC values greater than 0.9 for both limbs. The use of these two tests in particular can be advocated for assessing passive lower limb flexibility in rugby players. Using the hand held dynamometer is a practical option for experienced physiotherapists conducting passive flexibility tests.

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