RELIABILITY OF CLINICAL ISOKINETIC DYNAMOMETRY IN PATHOLOGICAL ATHLETIC SHOULDERS

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INTRODUCTION

Isokinetic dynamometry has been widely used in clinical applications for several decades now, most often in the assessment of knee extensor-flexor strength in orthopaedic sports medicine. More recently, there has been increased interest in its use for the assessment of the shoulder joint. If the findings of such assessments are to be used for making clinical judgements and clinical theory building in the management of shoulder problems (e.g. Warner et al., 1990), it is vital that the confidence limits of the results of such testing are apparent. In addition to this clinical context, one often encounters athletes with current or previous shoulder injuries during the routine testing of elite athletes in upper-limb sports. Therefore, it is also important to know the confidence limits for data collected from such individuals.

While the reliability of isokinetic testing of concentric knee extension-flexion has been widely assessed, such investigations have focussed almost exclusively on healthy, uninjured subjects (see Nitschke 1992 for review). Likewise, while there are a number of studies of the reliability of isokinetic shoulder testing (Frisiello et al., 1994; Greenfield et al., 1990; Hageman et al., 1989; Hellwig & Perrin, 1991; Keskula & Perrin, 1994; Kuhlman et al., 1992; Mayer et al., 1994; Ng & Cole, 1992; Perrin 1986), only one known study has investigated clinical patients (Malerba et al., 1993). The subjects in this latter study had a range of activity levels, from sedentary to highly active. Furthermore, all existing studies have involved a level of procedural standardisation which, while desirable, cannot always be achieved in a clinical environment, that is, where most isokinetic testing is performed. Given this, it is ironic that the reliability of testing in the clinical context has rarely been tested. It would seem to be a rash assumption that injured patients would be as reliable as healthy individuals when performing maximal isokinetic contractions.

Reliability studies have generally focussed on the reliability of absolute torque scores, such as peak torque. In clinical practice, these scores are probably the least often used. Absolute scores can only be used if they can be related to a normative value, or to the patient's score at another point in time. As useful normative data is not readily available, and patients' single tests must often be judged on a 'one-off' basis, the reliability of absolute scores is of somewhat limited interest. Rather, tests are often judged on the basis of inter-limb ratios for a particular muscle group, and agonist-antagonist ratios. Despite this common practice, the reliability of these ratios has never been examined for shoulder joint testing.

Therefore, the aim of this study was to assess the reliability of a protocol for isokinetic testing of pathological athletic shoulders in a clinical environment, under routine clinical conditions. Furthermore, the relative confidence limits of different data expressions and ratios was investigated.

METHODS

22 athletic patients (18 male, 4 female, mean age 26 years) presenting with a range of shoulder conditions including post-subluxation, post-dislocation, and post-surgical reconstruction were tested. 18 of the involved shoulders were the dominant shoulder. The patients were from a range of sports, including football (Australian Rules), baseball, rowing, swimming, and paddling. Patients were tested on two occasions, separated by a time interval during which their clinical status was not expected to change (most tests were one week apart; mean interval 10 days). Bilateral isokinetic strength of the shoulder internal rotators (IR) and external rotators (ER) was tested on a Cybex 6000 dynamometer (Cybex, Ronkonkoma, New York) at 2.09 and 4.19 radians/second (concentric) and 2.09 radians/second (eccentric). The tests at 2.09 radians/sec (120 deg/s) involved 4 repetitions; the test at 4.19 radians/sec (240 deg/s) involved 20 repetitions. There were no pauses between movements within a test. The uninvolved side was tested first. Patients received approximately 30 seconds rest between velocities, and 2-3 minutes between limbs. Patients were tested in a seated position, in 45 degrees of shoulder abduction and 90 degrees of elbow flexion. They grasped the lever arm via a hand grip. The projected dynamometer rotational axis was approximated to the long axis of the humerus. Range of motion was from physiological external rotation limit (approximately 90 degrees) to approximately 80 degrees of internal rotation. No compensation for gravitational torque was performed, as the Cybex software does not allow it for this movement. Tests were performed in essentially the same fashion on each occasion by the same tester, however the constraints of a busy clinical environment meant that precise control and exact replication may not have always been achieved.

The following measurements were taken from each test: peak torque (N.m; highest value achieved), 'best work rep (BWR)' (joules; repetition with highest work), total work (joules; work from all repetitions), and average power (watts; repetition with highest average power). These were expressed as absolute scores, and as ratios (percentages) of internal to external rotation (IR / ER %) and involved limb to uninvolved limb (INV / UNINV %). To assess test-retest reliability, intra-class correlation coefficients (ICC) and standard errors of measurement (SEM) were calculated.

RESULTS

Table 1 shows ICC and SEM for peak torque, total work, 'best rep work', and average power. Both absolute and ratio expressions (IWER % and INV/UNINV %) are shown. SEM is expressed in both the units of measurement, and as a percentage of the mean score (to allow comparison between different measurement parameters).

TABLE 1: Intraclass correlation coefficients (ICC) and standard errors of measurement (SEM) for peak torque, total work, 'best work rep', and average power

Mode	Angular Velocity radls	Limb	Movement	Peak Torque			Total Work			'Best Work Rep'			Average Power		
				ICC	SEM	SEM %mean	ICC	SEM	SEM %mean	ICC	SEM	SEM %mean	ICC	SEM	SEM %mean
CONC	2.09	UNINV	IR	0.96	3.03	6.31	0.93	28.38	8.30	0.96	5.70	6.28	0.93	7.13	9.42
CONC	2.09	UNINV	ER	0.95	2.60	8.29	0.88	25.32	12.74	0.90	5.80	11.06	0.92	4.54	10.07
CONC	2.09	UNINV	IR/ER%	0.79	16.99	10.69	0.79	20.94	11.61	0.87	16.11	8.93	0.86	18.36	10.49
CONC	2.09	INV	IR	0.94	4.29	8.62	0.95	26.75	7.93	0.94	7.29	8.23	0.95	6.51	8.24
CONC	2.09	INV	ER	0.95	2.24	7.76	0.94	17.82	10.05	0.95	4.14	8.90	0.94	3.93	9.50
CONC	2.09	INV	IR/ER%	0.89	14.02	7.75	0.80	52.78	23.82	0.91	28.42	13.04	0.92	25.28	11.85
CONC	2.09	INV/UNINV %	IR	0.40	11.37	10.56	0.65	13.33	12.80	0.76	9.50	9.32	0.26	20.70	18.58
CONC	2.09	INV/UNINV %	ER	0.69	9.00	9.76	0.59	14.91	17.22	0.78	10.42	12.20	0.65	12.46	13.86
CONC	4.19	UNINV	IR	0.96	2.61	6.24	0.94	105.84	7.96	0.93	5.89	8.09	0.96	8.82	7.36
CONC	4.19	UNINV	ER	0.95	2.15	8.64	0.94	59.14	10.95	0.91	4.41	12.67	0.91	7.02	12.47
CONC	4.19	UNINV	IR/ER%	0.74	19.34	11.04	0.71	45.90	16.90	0.61	39.29	17.38	0.67	39.43	17.13
CONC	4.19	INV	IR	0.95	3.31	7.74	0.94	111.86	8.56	0.94	5.93	8.36	0.94	10.70	8.73
CONC	4.19	INV	ER	0.91	2.66	11.58	0.96	45.16	9.21	0.94	3.68	11.83	0.93	6.01	11.59
CONC	4.19	INV	IR/ER%	0.93	16.15	8.02	0.99	35.67	9.59	0.98	27.42	9.44	0.97	31.02	10.58
CONC	4.19	INV/UNINV %	IR	0.53	9.78	9.21	0.80	9.04	8.76	0.74	10.19	10.04	0.64	10.80	10.03
CONC	4.19	INV/UNINV %	ER	0.52	13.77	14.95	0.70	16.13	18.48	0.60	17.62	20.70	0.59	18.96	21.14
ECC	2.09	UNINV	IR	0.83	7.01	12.36	0.82	47.90	12.40	0.78	14.10	13.48	0.68	12.54	17.34
ECC	2.09	UNINV	ER	0.91	3.35	8.39	0.83	31.10	11.66	0.84	8.24	11.20	0.82	7.26	13.08
ECC	2.09	UNINV	IR/ER%	0.77	13.53	9.37	0.62	17.24	11.70	0.57	18.76	12.94	0.57	21.10	15.61
ECC	2.09	INV	IR	0.97	3.57	6.37	0.94	34.53	9.11	0.95	8.48	8.37	0.81	11.70	16.53
ECC	2.09	INV	ER	0.94	3.06	8.32	0.93	27.20	11.07	0.94	6.57	9.78	0.93	5.22	10.00
ECC	2.09	INV	IR/ER%	0.65	19.59	12.52	0.88	17.17	10.40	0.86	18.69	11.55	0.55	29.98	20.98
ECC	2.09	INV/UNINV %	IR	0.65	14.57	14.24	0.63	17.38	17.18	0.56	19.23	19.18	0.39	23.35	22.92
ECC	2.09	INV/UNINV %	ER	0.73	9.65	10.57	0.78	11.77	13.19	0.74	11.89	13.41	0.64	13.89	14.83

UNINV = uninvolved limb; INV = involved limb
IR = internal rotation; ER = external rotation

DISCUSSION

The reliability of absolute concentric values for peak torque, work, total work, and average power were all above 0.9, indicating that these measures are highly reliable in the sample studied. The reliability of eccentric measures was only slightly lower, but was still generally above 0.8. Standard errors of measurement ranged from a low of around 6 % of the mean for the most reliable measures, to 15-20 % of the mean for the least reliable. The 68 % confidence limits for the 'true' score are given by + /- SEM; the 95% confidence limits are + /- 2 SEM.

Perhaps the most striking pattern apparent in the data was the lower reliability of the ratio scores (IR / ER % and INV / UNINV % for IR and ER). The results suggest that one must accept a substantially broader confidence interval for these measures than for the absolute constituent scores.

CONCLUSION

In the clinical environment studied here, reliability of absolute values for peak torque, work, total work, and average power were as good as, or better than has been previously reported for normals under laboratory conditions (see references in Introduction).

Reliability of commonly used clinical ratios, such as IR / ER % and INV / UNINV % for IR and ER, tended to be lower than the reliability of absolute scores, and in some cases was quite poor. Caution in the use of these ratios is therefore warranted.

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