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CLINICAL DIAGNOSIS OF STRENGTH AND POWER ASYMMETRY

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SUMMARY

This paper outlines the difficulties in diagnosing bilateral strength & power asymmetry of the lower limbs and aims to introduce the term 'absolute asymmetry' as a diagnostic tool for identifying bilateral asymmetry.

INTRODUCTION

Bilateral asymmetry (BA) is a term frequently used in the fields of rehabilitation as well as performance sport, describing substantial deviation from normative data or muscle performance differences between limbs (Schlumberger *et al*., 2006). Muscle strength asymmetry may develop through dominancy, incomplete rehabilitation, previous injury and specific motor demands of different sports and training methods (Krawczyk *et al*., 1998). These have been postulated to be risk factors for injury development and reoccurrence (Lawson *et al*., 2006; Newton *et al*., 2006).

Strength imbalances have been examined utilising a variety of testing methods and modes; open and closed chain, unilateral versus bilateral movements (Croisier *et al*., 2008). However, there is no definitive criteria for the clinical diagnosis of asymmetry, with notional (arbitrary) values of 10-15% (Impellizzeri *et al*., 2007) being suggested. These values do not appear to have any logical rationale and lack scientific justification. Moreover, there are several issues with respect to how a 'normal' difference between limbs is determined. Studies (Newton et al., 2006, Croisier *et al*., 2008) that have compared left and right limbs tend to find close to zero differences in mean strength/power and rely on some measure of variance between subjects (which does not provide a relevant measure of a typical difference). Others (Rahnama *et al*., 2005, Newton et al., 2006) have classified limbs as dominant and non-dominant, which leads to an unsatisfactory outcome as the definition of dominance is ambiguous. For example with prolonged practice in a unilateral skill such as kicking leads to the development of an asymmetrical profile, whereby the support leg becomes stronger eccentrically and the kicking leg becomes stronger concentrically (Rahnama *et al*., 2005).

Within closed chain bilateral tests the majority of analyses have focused on either the difference between peak and average (AVG) forces over the force production phase. It is likely that differences may be found in eccentric (ECC) and concentric (CON) phases of the movements, e.g. countermovement jumps and such a diagnosis will lead to a more informed and specific intervention plan (Sannicandro *et al*., 2011). The aim of this study is to introduce the term 'absolute' asymmetry and establish true values for typical levels of asymmetry in open and closed chain and unilateral and bilateral tests.

METHODS

Sixty three injury-free elite and sub-elite athletes from a range of sports participated in the study (57 males, 6 females, mean±SD: age 22.5±4.2 years, height 180±9.0 cm and weight 83±17.5 kg). Ethical approval was granted from the University of Salford ethics committee.

All subjects underwent a battery of tests in a randomised order on the same day. Subjects were familiarized with the tests prior to data collection. The tests were as follows:

Open chain (OC): Isokinetic strength of the Q and H muscle groups in both CON and ECC modes was tested at an angular velocity of $60^{o}/s^{-1}$ on an isokinetic dynamometer (Biodex System 4 Pro, Corp., Shirley, NY). The gravity corrected peak torque over 5 repetitions was determined.

Closed chain (CC) (bilateral): Three maximal effort countermovement jumps were performed on two PASCO (Roseville, California) force platforms. Prior to testing the plates were reset and the subjects body weight was measured ensuring agreement between force measures fell within 5N. Subjects jump with a broom handle across their shoulders to isolate the lower limbs. Onset of movement was determined by a deviation of 20 N from body weight. Peak forces within the movement phase and AVG forces in ECC, CON and overall movement were determined. The transition between ECC and CON phases was determined by the position of maximum displacement following double integration of the acceleration data.

Closed chain (unilateral): Three different tests were administered to determine unilateral power development: A single leg countermovement (SLC) using the methods described above, a single leg hop (SLH) for distance and a triple hop (TLH) for distance. Performance in the hop tests were measured using a tape measure from the toe at take-off to the heel at final landing. For all jump tests the average of the three performances was taken for further analysis.

Asymmetry was calculated using the formula:

[(Left leg – Right Leg)/(Max of Left or Right leg)] x 100.

RESULTS AND DISCUSSION

Table 1 presents mean ± SD OC and CC scores for right and left limbs along with absolute asymmetry between limbs. Table 1 shows that absolute asymmetry scores are generally below 10% and provide little support for the notional 10-15% often suggested in the literature (Impellizzeri *et al*., 2007). Furthermore, the absolute asymmetry scores vary considerably between the different test modalities, suggesting that to diagnose asymmetry specific criteria should be used for different tests.

CONCLUSIONS

The 'typical' level of bilateral asymmetry (i.e. the mean absolute difference) varies between different testing modalities ranging from 10.3% (H CON) to 0.8% (Avg. whole of the bilateral countermovement jump). Therefore arbitrary values of 10-15% can be considered too conservative and do not reflect the mode of test utilised. Thus, the diagnosis of bilateral strength/power imbalances should have specific criteria dependent on the mode of test used. The data presented in Table 1 can be considered typical asymmetry scores for uninjured athletes for each test, which can help identify bilateral strength/power imbalances.

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Table 1: Mean ± *SD* and absolute asymmetry as a percentage for the OC & CC measurements of both the right and left legs for all subjects (n=63).

TEST	Right Mean ± SD	Left Mean ± SD	Avg. Asymmetry Mean ± SD (%)	Absolute Asymmetry Mean ± SD (%)
OPEN CHAIN				
Q CON	224.7 ± 42.5	227.4 ± 38.2	-1.84 ± 9.37	**8.29 ± 6.43**
H CON	118.6 ± 22.6	109.8 ± 17	-3.12 ± 9.87	**10.28 ± 5.96**
CLOSED CHAIN				
Bilateral test				
Peak	927.7 ± 198.3	965.3 ± 197.2	-5.0 ± 13.7	**8.37 ± 11.95**
Avg. (whole)	819.5 ± 170.5	822.5 ± 170.6	-0.4 ± 1.9	**0.79 ± 1.82**
Avg. ECC	424.4 ± 89.7	427.0 ± 129.5	-2.1 ± 32.4	**8.47 ± 6.54**
Avg. CON	774.5 ± 160.6	758.1 ± 169.5	1.8 ± 11.5	**6.49 ± 5.06**
Unilateral Test				
Peak	1538 ± 297	1545 ± 319	-0.5 ± 7.1	**5.10 ± 4.88**
Avg. (whole)	913.4 ± 206.8	917.7 ± 222.1	-0.4 ± 5.6	**2.69 ± 4.95**
SLH	169.4 ± 32.73	168.1 ± 32.74	0.26 ± 11.61	**7.63 ± 8.68**
TLH	558.3 ± 81.22	563.8 ± 89.74	-0.98 ± 7.58	**5.06 ± 5.67**