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Maximality of shoulder external rotation effort in patients presenting with work related injury: The clinical applicability of the DEC parameter

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ABSTRACT

The aim of the present study is to examine the applicability of the isokinetic DEC parameter for identifying submaximal effort in workers with potential weakness of the shoulder external rotators. A previous study indicated that the DEC was a powerful identifier of submaximal effort of shoulder external rotation in normal volunteers. Its applicability in shoulder injury patients is of specific interest. Thus, a retrospective study of 74 (33 female and 41 male) patients who claimed compensation for work-related shoulder injury was designed. 52 patients had their injured side DEC values within the normal range and were thus labeled as maximal performers. Ten patients had higher than cutoff DEC values, indicating submaximal effort whereas 12 patients had exceedingly low DEC values. Gender comparison showed a significantly different proportion of maximal performers. Strength deficits registered in patients demonstrating maximal performance correlated with the final outcome. The findings support the application of the DEC for determination of the extent of weakness of shoulder external rotators in male patients. In terms of shoulder external rotators status in male worker injury, the results support the application of isokinetic tests both in the clinical and medicolegal sense. However, the gender discrepancy warrants further research.

1. Introduction

Shoulder injuries are a major management problem in musculoskeletal rehabilitation and occupational medicine settings. A 1-year prevalence study of shoulder pain interfering with occupational activities indicated a rate of 9% (Palmer et al., 2001). Most patients require extensive treatment with drugs, physical therapy and in some cases, surgery. Following treatment return to work may be difficult. Due to their high prevalence, the economic consequences of shoulder pain are enormous (Waehrer et al., 2005). Regarding workers' compensation patients, it has been well documented that work injury is associated with poorer outcomes, especially following surgery (Koljonen et al., 2009; Viola et al., 2000; Sallay et al., 2005). It has been postulated that this phenomenon was caused by the fact that most commonly adopted shoulder-specific functional outcome measurement tools are subjective in nature (Koljonen et al., 2009). Thus, objective and precise evaluation of the deficits and determination of the degree of potentially permanent impairment are highly desirable in order to facilitate decision making in worker compensation shoulder injury patients.

One of the major manifestations of shoulder injury causing dysfunction is muscle weakness. Objective evaluation of shoulder muscles performance is therefore of a significant value. It provides information essential for treatment or rehabilitation, as well as assessment of clinical outcomes and permanent impairment which might interfere with work ability. Isokinetic dynamometry enables accurate and reproducible measurement of muscle strength (Greenfield et al., 1990; Plotnikoff and McIntyre, 2002). However, patient maximal effort is crucial in order to produce meaningful results. Indeed for both clinical and medico-legal decisions, estimation of the patient maximal effort is crucial. It has been demonstrated that a powerful tool for assessing maximallity of effort is the DEC, a parameter that derived from the numeric difference between the eccentric/concentric strength ratios at relatively high and low test velocities. Specifically, the DEC was highly effective in identifying submaximal muscular effort in normal subjects (David et al., 1996; Dvir and David, 1996; Dvir, 1997a,b; Dvir,

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1999; Dvir and Keating, 2001; Dvir et al., 2002; Chaler et al., 2007; Olmo et al., 2009) as well as in patients (Dvir, 2002). The physiological rationale for the method derives from the different mechanical output of eccentric and concentric contractions, especially when performed at a submaximal level. In submaximal contractions the ability to control muscle tension differs significantly between the two contraction modes. Thus, as far as concentric activity is concerned, when subjects are asked to perform submaximally the difference between their strength output at low and high velocities is quite considerable. In contrast, the drop in eccentric output is rather moderate. Based on these variations it was suggested that by comparing Ecc/Con Rations related to velocities that are set a sufficiently large gradient, one could potentially differentiate between maximal and submaximal effort (Dvir, 2004). The efficiency of the DEC in identifying maximality of shoulder external rotation effort has been demonstrated in a group of male volunteers (Chaler et al., 2007) but not in patients.

Therefore, the objective of the present study was threefold: 1. to examine the use of the DEC in identifying suboptimal effort in patients suffering from work related injury to the shoulder external rotators, 2. to assess the significance of gender in DEC-based evaluation, 3. to analyze the usefulness of isokinetic testing of shoulder external rotation strength for evaluating long term patients with shoulder injuries who seek compensation.

2. Material and methods

2.1. Subjects

74 unilateral shoulder injury patients (33 women and 41 men), aged 18–65 years (48.1 ± 10.2) participated in the study (Table 1). All participants were seeking compensation for work-related injuries affecting shoulder external rotation function. In all patients this dysfunction had a potential medico-legal context in terms of various secondary gains such as avoiding onerous work duties and/or seeking economic benefits. The objective of the test was to help decision making regarding return to work planning and/or compensation allocation. All subjects received a talk from the testers before the actual test. They were instructed about test protocol and aim. The importance to perform a maximal effort during the test in order to obtain meaningful results was highlighted during the talk. They also signed an informed consent form before the test was performed. The study design was approved by the local IRB.

Table 1
Baseline demographics diagnosis and work related outcomes. Comparison between genders. Note that, as expected, the only significant difference among groups is found in weight (*). Diagnosis proportion differences were not significant between genders.

	Female	Male
No. of worker compensation patients included	33	41
Mean age (yr ± SD)	48.48 ± 9.6	47.78 ± 10.84
Mean weight (kg ± SD)	67.97 ± 10.74	80.34 ± 11.67*
Mean process duration (days ± SD)	271.24 ± 168.99	306.49 ± 242.54
Diagnosis		
Impingement/rotator cuff tendinosis	12	15
Arthroscopic surgery	10	4
Rotator cuff surgical reconstruction	7	8
Instability	1	7
Other	3	7
Outcomes (work related)		
Complete healing	20	22
Impairment, no disability	5	4
Impairment, partial disability	1	2
Impairment, total disability	7	13

2.2. Testing protocol

The testing protocol for isokinetic shoulder external rotation strength has been previously described (Chaler et al., 2007). A Cybex Norm® isokinetic dynamometer (Rokonkoma, New York) was used. The device was fully calibrated before every test. Warm up and testing was conducted with the subject seated on an adjustable seat and proximally stabilized using cross chest straps. The arm was positioned in the scapular plane, between 30° and 45° anterior to the frontal plane and elevated 45°. Goniometry was used to check positioning. Elbow was maintained at 90° flexion and supported by a standard shoulder rotation attachment. A forearm strap helped positioning the elbow. The forearm remained neutral during the testing protocol while the hand grasped a handle connected distally to the lever arm. The mechanical axis of the lever arm was aligned with the humeral shaft (see Fig. 1).

The test protocol started with familiarization and warm up. It consisted of one set of 10 increasing submaximal concentric contractions, one set of 10 increasing submaximal eccentric contractions, a 2 min rest period and two short (3 or 4 contraction) set of maximal concentric and eccentric contraction respectively. After 3 min rest the actual test started. Testing was performed bilaterally starting on the injured side. The test range of motion (RoM) was 60°, starting from 55° internal to 5° external rotation. During the test performance, subjects were asked to exert maximal effort against the lever arm whose angular speed was first set at 30°/s. The test consisted on four pairs of intermittent, reciprocal, concentric-eccentric contractions with a 5 s inter-contraction pause and a 25 s interpair pause. Following a 5 min pause, speed was then raised to 120°/s and the same protocol was applied again. Allowing a 5 min pause, testing of the uninjured side was then conducted applying the same protocol.

2.3. Data reduction and statistical analysis

Demographic (weight, age), injury (diagnosis and process duration in days) and outcome data were registered for each patient.

Fig. 1. Patient positioning: humeral shaft is in the scapular plane and, at the same time, aligned to the dynamometer rotation axis.