A Note on Methods of Testing for Human Performance Capacity

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INTRODUCTION

Over the last twenty-five years there has been a rapid development of methods and systems available for the purpose of testing human joint function and capacity. Technological developments have allowed for the production of reliable and valid instruments that have been used in a wide variety of applications. The purpose of this paper is to address issues associated with the use of various human performance testing procedures, with particular attention to applications of initial and return-to-work assessments.

TEST PROCEDURES

Numerous tests of muscle capacity are available. Typical isotonic testing must be modified depending on the mechanics, such as the need to account for the effect of gravity and the velocity with which any mass is moved. There is no easy way to control for these factors, and thus any simple system cannot produce credible results that are easily managed by clinicians. Isometric contractions have the limitation that they are not representative of the work task to be performed. By the very nature of isometric contractions there is no shortening or lengthening of muscle, thus not simulating what occurs in the natural environment. Isometrics have wide applications and are primarily useful when testing clients with pathology that limits joint motion. This testing is thus usually eliminated from use in work settings because of the need for dynamic activities.
Both **isokinetic** and **isoinertial** testing have the advantage of producing quantifiable values for muscle performance. Proponents of the isoinertial technique take the position that this technique “more closely mimics the functional performance of the muscle-joint system”. (Lavangie and Norkin) However, finding relevant information in textbooks and in the peer-reviewed literature (journals) is much more difficult for the isoinertial method of testing. Further, this mode of testing of human performance is not most commonly used. Limited availability of equipment for isoinertial testing has also been somewhat problematic. Preparation time and completion of the testing protocol is approximately equivocal for isoinertial and isokinetic testing.

**Functional capacity evaluations** (FCE) are also being used for worker assessment and in determinations of return to work. King et al provided, in a 1998 article, a critical review of FCEs, comparing the characteristics of 10 of the available systems. These authors point out that “research to justify the use of FCEs is lacking”. The amount and type of test inclusions, data objectivity, reliability and validity are also issues that need to be addressed. Reliability and validity have been somewhat addressed, as in the representative work of Lechner (1994) and Gross and Bättie (2002). The issues above and the specificity necessary for the FCE test results to be meaningful may be limiting factors to their use. Further research is necessary to clarify the importance of these procedures as they are now used.

A system using isokinetic testing has multiple advantages, the foremost of which is the capability to determine maximum torque generating capability under a broad spectrum of movement velocities. These velocities can be selected based on the requirements of a specific job or selected movement of interest, thus matching the job to be performed. While most sites would be interested in testing during a maximum effort, the dynamometer only resists the magnitude of the effort. Thus, this system has been known to produce the “perfectly accommodating resistance” so that in the instance where the subject reduces the magnitude of their effort the machine would only apply an accommodating magnitude of torque. Some have at least speculated that the magnitude of joint compressive forces is
lower in isokinetic testing. (Davies) Further, instruments used have been shown to be valid and reliable, given they are managed by experienced users. (Hanten and Lang, Patterson and Spivey, Farrell and Richards) More research has been done on this issue for isokinetic test devices than for other test units. Data from isokinetic testing is also easy to manage and values can be entered into a large database for determining the level of performance of any subject and joint(s) tested.

**DISCUSSION**

The literature includes some comparative studies of isokinetic and isoinertial systems of testing. (Curtis et al, Murphy and Wilson, Abernethy and Jurimae) The results of these published studies are likely representative of the pool of literature, although a National Library of Medicine search revealed only these three works that compared more than one test protocol. For example, Murphy and Wilson reported that “both isoinertial and isokinetic parameter were related to measures of upper body performance, however, neither was superior at predicting performance”. Abernethy and Jurimae reported that although isokinetic, isoinertial, and isometric measures “discriminated similarly” in their upper extremity testing, there were differences in the “sensitivity of the strength measures to the effects of training”. In the Curtis et al. work, some post-discectomy patients demonstrated higher isokinetic lifting forces than the unoperated patients. A similar achievement was not found for the isoinertial lifting test. And, in a study of isoinertial tests to predict lifting performance, investigators have reported that they were able “to account for only 30 to 50 percent of the variance in the performance of maximal lifting and endurance tasks” with these methods. (Stevenson)

The most important question may be: Does isokinetic testing simulate or is it really related to the performance requirement in the work setting? While there is little to establish a solid relationship between the two there are at least some studies that suggest such. For example, Westblad et al. reported, in 1996, a substantial relationship between isokinetic extensor endurance of eccentric total work and concentric relative endurance to measures of treadmill running capacity.
Finally, and perhaps of key importance, is the familiarity of health care practitioners with the use and results of each of the methods. While there are no specific data available that address this issue it is of interest that the literature predominantly reports on isokinetic testing of injured joints. This is substantiated in a Pub Med/National Library of Medicine literature search where using the topic of isokinetic 2345 citations were identified while the topic of isoinertial produced only 54 citations over the same time interval of analysis.

**SUMMARY**

This note provides a brief overview of various systems or techniques used in assessing patient’s capacity to perform. A significantly greater effort would be required to provide a more comprehensive view of the subject. No known comparison of the various methods is known to exist in the literature. Rather, all of these systems exist because there has been no systematic development or critical appraisal of the schema available. Since Newton and Waddell reported in 1993 that “there was inadequate scientific evidence to support the use of iso-machines in pre-employment screening, routine clinical assessment or medico-legal evaluation” there has been increased use of FCE, isokinetic, isoinertial and other methods to evaluate clients preparing for or attempting to return to the work setting. Many advantages apply to each of the testing procedures, but the primary ones for isokinetic and isoinertial methods is that data are quantifiable and applicable to the task being performed, given that the test procedure closely simulates the work requirement. Clearly, additional research needs to be completed in order to differentiate between the utility and application of the systems to the testing of human capabilities. Because of the predominance of isokinetic testing, familiarity with the output form by clinicians, and high likelihood of continued use and data presentations, isokinetic testing will likely become the most preferred and credible form for assessing the probability of injury, the effects of injury, or the capacity of an individual to return to participation, either in sports or in the work environment.
References


