

Decision-Making Data

Expectations for Reproducibility of Lifting on Separate Days

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ABSTRACT

Purpose: The purpose of this study was to explore the difference in maximal lifting capability between 2 modes of lifting (traditional crate and XRTS Lever Arm) over multiple days. The differences in absolute strength values were compared with existing criteria for sincere effort during distraction-based lifting. In addition, rate of perceived exertion (RPE) is presented for the 2 modes of lifting on each day.

Primary Practice Setting: Workers' compensation.

Methodology and Sample: Forty-four subjects between the ages of 20 and 44 years participated in this study. Investigators established 1 repetition maximum (RM) for each subject performing the crate lift. Subjects were randomly assigned 5 weights ranging from 10% to 100% of their determined 1RM and asked to give their rating of perceived exertion after each lift. The same procedure was repeated 2–5 days later using the XRTS Lever Arm. Paired *t* tests and Spearman's correlation coefficient were used for data analysis. Alpha was set at less than .05.

Results: There was a statistically significant difference ($p < .04$) between maximal lift values for the 2 lifting modes. The percent difference between the modes of lifting was $10.5\% \pm 6.4\%$. In addition, there was a positive correlation between the RPE on the 2 modes of lifting ($p = .87$).

Implications for Case Management Practice: A functional capacity evaluation (FCE) is typically ordered after the completion of physical rehabilitation and before releasing a patient to full or modified duty. In addition to assessing the ability to function within normal job demands, an assessment of effort by the participant typically takes place during an FCE. Case managers and physicians are presented with information, allowing them to make comparisons between functional lifting abilities displayed during treatment sessions and the FCE. These comparisons may often take place with the subpoena of medical records and may be discussed during the deposition or trial process. If an FCE takes place at a different facility than the physical therapy or work conditioning treatment, 2 different modes of lifting may take place based on the equipment within each facility. The results of this study indicate that the 2 modes of lifting on separate days meet established criteria for lift comparison testing during FCEs.

Key words: *distraction-based testing, effort testing, perceived exertion, functional capacity evaluation (FCE)*

According to the Centers for Disease Control and Prevention, in 2012, the U.S. civilian labor force comprised an estimated 155 million workers (Baron, Steege, Marsh, Menendez, & Myers, 2013). In 2011, approximately 3 million workers in private industry and 821,000 workers in state and local governments experienced a nonfatal occupational injury or illness (Baron et al., 2013). Nonfatal workplace injuries and illnesses are estimated to cost the U.S. economy approximately \$200 billion annually (Baron et al., 2013). In 2015, according to the Bureau of Labor Statistics, there were approximately 2.9 million nonfatal workplace injuries and illnesses reported by private industry employers, which occurred at a rate of 3.0 cases per 100 equivalent full-time workers (Bureau of Labor Statistics, 2016).

Once a worker is injured, he or she participates in a workers' compensation program that involves a team of individuals in the case management process

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to make decisions regarding an injured worker's ability to return to work. Self-limiting behaviors such as pain, fear of pain, fear of reinjury, anxiety, depression, lack of understanding of the rehabilitative process, and secondary financial gain are some of the reasons underlying an injured worker's ability to give sincere effort in treatment and final evaluation for return to work (Lechner, Bradbury, & Bradley, 1998).

BACKGROUND

Sincerity of effort refers to an injured worker's conscious motivation to perform optimally during an evaluation. A sincere effort is the injured worker's best or optimal physical performance, whereas an insincere effort is one in which the injured worker gives less than a full effort during physical examinations. Injured workers whose efforts are not sincere during evaluation may overuse treatment, have a prolonged recovery, have an increased cost of care, or may receive unwarranted disability payments. If any part of the case management team determines and documents that an injured worker is not putting forth a sincere effort, this may result in negative legal and financial consequences for the injured worker being evaluated for return to work. It is imperative that statements regarding the sincerity of patient effort demonstrated during objective functional tests be based on validated procedures.

Functional capacity evaluations (FCEs) are test programs designed to measure an injured worker's ability to perform a functional task. These tests are typically administered in an occupational rehabilitation setting with the goal to determine an injured worker's preparedness to return to work. To determine an injured worker's ability to return to work, the test is made up of movements related to the task(s) that the injured worker performs and also consists of a load that will sufficiently prove his or her ability to lift/carry/handle loads throughout the day. In rehabilitation settings, the crate lift has long been thought of to be the "gold standard" of FCE testing. This test consists of having an injured worker lift a crate from one surface to another. The weight of the crate and the surface heights are normally varied to mimic the varying tasks expected of the injured worker. The caveat to this testing is that the injured worker must provide a sincere

maximal effort in order for the FCE to be considered a true measurement of one's ability (Oesch, Meyer, Bachmann, Hagen, & Vøllestad, 2012). If an injured worker does not provide a sincere effort, the FCE would not provide a valid measure of his or her ability to return to work (Schapmire, St. James, Townsend, & Feeler, 2011). Knowledge of validity of effort during functional testing allows those from the medical and legal communities and those from the insurance industry to make informed decisions regarding the worker's ability to return to work (Lechner et al., 1998).

REVIEW OF LITERATURE

Researchers within the field of functional testing indicate the need for determining the validity of tools assessing effort (Brubaker et al., 2007). The measurement of an injured worker's level of effort during the FCE has included documentation of visual estimation of effort, heart rate as a measure of exertion, repeated measures assessed by coefficients of variation (CVs), rate of perceived exertion (RPE), and distraction-based testing.

Visual Estimation of Effort

Sincerity of effort in lifting tasks has been predominantly determined by visual estimation of effort by the tester. Research using this method focused on reliability of the classification of effort between trained evaluators (Isernhagen, Hart, & Matheson, 1999). However, because consistency among ratings does not reflect accuracy of ratings, many have cautioned against the use of visual observation as a way to measure effort (Barron, 2011; Schapmire et al., 2011; St. James, Schapmire, Feeler, & Kleinkort, 2010). Schapmire et al. (2011) reported no difference in the classification of effort observed by untrained observers and trained/experienced medical professionals. Reneman, Fokkens, Dijkstra, Geertzen, and Groothoff (2005) caution that despite the wide use of visual observations as a sincerity of effort measure, no evidence has been published that addressed its reliability and validity for use with FCEs (Owen & Wilkins, 2014). One study concluded that effort levels were determined valid and reliable by observation during a lifting assessment (Reneman et al., 2005).

If any part of the case management team determines and documents that an injured worker is not putting forth a sincere effort, this may result in negative legal and financial consequences for the injured worker being evaluated for return to work. It is imperative that statements regarding the sincerity of patient effort demonstrated during objective functional tests be based on validated procedures.

Heart Rate as a Measure of Exertion

Heart rate as a measure of exertion has been debated in FCE literature (Morgan, Allison, & Duhon, 2012; Schapmire et al., 2011). Based upon the heart rate theory, the more effort being exerted by the worker during the FCE, the higher his or her heart rate (Schapmire et al., 2011). Heart rate is also affected by medication, test anxiety, and other physical conditions (Barron, 2011; Gross & Battié, 2005, 2006; Kaplan, Wurtele, & Gillis, 1996; Schapmire et al., 2011). Maximum heart rate is typically calculated using the following equation: Maximum Heart Rate = 220 – Age (Schapmire et al., 2011). In a review of literature on measuring maximum heart rate, the standard error of estimate within a 95% confidence interval was 40 beats/min (Robergs & Landwehr, 2002). For example a 50-year-old man would have a maximum heart rate of 170 beats/min, with a standard error ranging between 130 and 210 beats/min. Given the significant variability in the reported standard error, using maximum heart rate as a measure of effort is questionable (Morgan et al., 2012; Owen & Wilkins, 2014; Schapmire et al., 2011).

Repeated Measures Assessed by Coefficients of Variation

Coefficients of variation are another measure utilized by FCE evaluators to determine sincerity of effort in FCE participants during isometric lift testing and isometric grip and pinch testing. Statistically, the CV is an expression of variability within a sample, some of which reflect measurement error and some of which reflect variability within subjects (Lechner et al., 1998). It is derived mathematically by dividing the standard deviation by the mean, with the result expressed as a percentage (Kaplan et al., 1996; Lechner et al., 1998; Townsend, Schapmire, St. James, & Feeler, 2010). Historically, 15% variability is allowed in FCEs, with more than 15% score variability reflecting unreliable or invalid effort (Schapmire et al., 2011). It is noted, however, that the 15% cutoff score has never been validated through a controlled study (Lechner et al., 1998; Schapmire et al., 2011). The larger objection to the use of CVs in measuring sincerity of effort is that CVs are measures of reliability and not validity (Owen & Wilkins, 2014).

Rate of Perceived Exertion

Finally, in a study by Eston (2009), results provided evidence that submaximal rates of perceived exertion (RPEs) can be used to provide reasonably accurate estimates of 1 repetition maximum (RM) in young and active men and women. The method provides proof of principle that submaximal exercise

intensities, in the range of 20%–60% of the 1RM, can be used to estimate the 1RM for upper- and lower-body exercises. It remains to be determined whether the use of alternative percentages of the 1RM (smaller increments in resistance) or whether practice in repeated submaximal perceptual estimation sessions with sufficient intermittent recovery periods would lead to greater accuracy in the prediction of 1RM. Further research to test these assumptions and assess the efficacy of using perceived exertion to predict the 1RM in other populations is recommended (Eston, 2009).

Distraction-Based Testing

An alternative mean of determining an injured worker's sincerity of effort is through distraction-based testing. Distraction-based testing implements methods to test and retest a certain functional task in a discrete manner. For example, Waddell, McCulloch, Kummel, and Venner (1980) compared measured hip flexion by subjects performing a straight leg raise in the supine and sitting postures. To apply this concept of distraction-based methodology, the XRTS Lever Arm (Cross-Reference Testing System) was created to allow for distraction-based testing comparing dynamic lifting capability from the same starting height and hand width placement in two different modes of lifting. The XRTS Lever Arm has been used in FCE testing as a more objective means of determining effort compared with traditional methods such as heart rate variations, reproducibility of isometric testing without distraction, and visual estimation (Townsend et al., 2010). The Lever Arm device has been shown to allow for accurate classification of effort for those giving a full 100% effort (Townsend, Bell, & Harry, 2016).

PURPOSE

The case management process of work injury requires a team of treating physicians and/or clinicians along with case managers and/or claims adjusters to make decisions regarding injured workers' ability to return to work based on their levels of functional lifting during work conditioning programs or physical therapy treatment compared with the sincere effort demonstrated in the FCE results. These comparisons made by the case management team often have expectations of similar results between function displayed in treatment and the sincere effort demonstrated in the FCE. Formal measurement of an injured worker's level of effort traditionally takes place during an FCE. Functional capacity evaluations are typically not performed until the end of treatment. There are typically multiple days separating the last day of therapeutic intervention and the FCE.

The purpose of this study was to explore the difference in maximal lifting capability between two modes of lifting (traditional crate and XRTS Lever Arm) over multiple days. The differences in absolute strength values were compared with existing criteria for sincere effort during distraction-based lifting. In addition, RPE is presented for the two modes of lifting on each day.

PRIMARY PRACTICE SETTING(S)

Workers' compensation outpatient or on-site clinical settings in which nurse case managers attempt to increase efficiency of return to work and case resolution.

METHODOLOGY AND SAMPLE

Sample

The Internal Review Board of a Midwest university approved this research project. A convenient sample of 48 subjects between the ages of 20 and 44 years was recruited to participate as subjects in this study. Inclusion criteria for all subjects included the subjects being healthy with no injury to the neck, arms, legs, or low back in the previous 12 months. Subjects were excluded if they were pregnant and if they could lift more than 100 lb while doing the crate lift. All subjects provided informed consent for participation in this study. In addition, demographic data including age, gender, height, and weight of subjects were self-reported.

Materials

The XRTS Lever Arm is a device that has been designed to replicate the biomechanics of the crate lift and is used to measure the maximal amount of weight a client can lift (St. James et al., 2010). Clinicians are using this device in clinics across the country and have found this tool to be useful in documenting objective progress in FCEs. Researchers and clinicians have developed a specific protocol to evaluate sincere effort using unmarked weights to add to a traditional 2.5-lb crate that is 12 in. × 12 in. × 10½ in. (see Figures 1 and 2) and the XRTS Lever Arm (see Figures 3 and 4). For the purpose of this study and performing the testing clinically, public knowledge to identify the value of each weight added to the crate or lever arm would diminish the accuracy and defeat the purpose of the test. The act of attempting to estimate the workload being lifted would add an element of dual tasking for the participant, which may increase the likelihood of failing established validity criteria. The identification of the absolute value of each weight is proprietary information to the owners of the testing system. Each weight used in this study was calibrated for accuracy. A

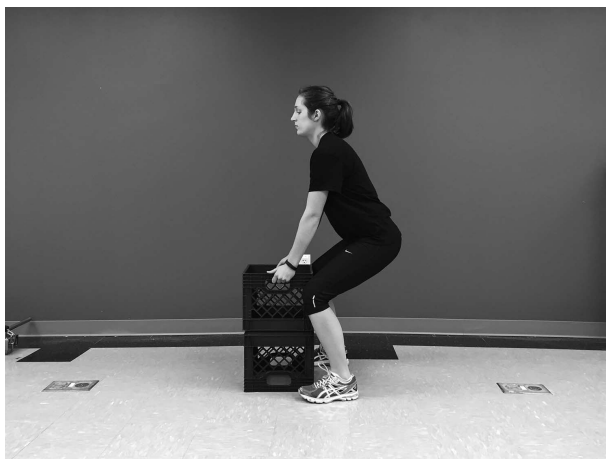


FIGURE 1
Crate lift start position. Used with permission.



FIGURE 2
Crate lift end position. Used with permission.

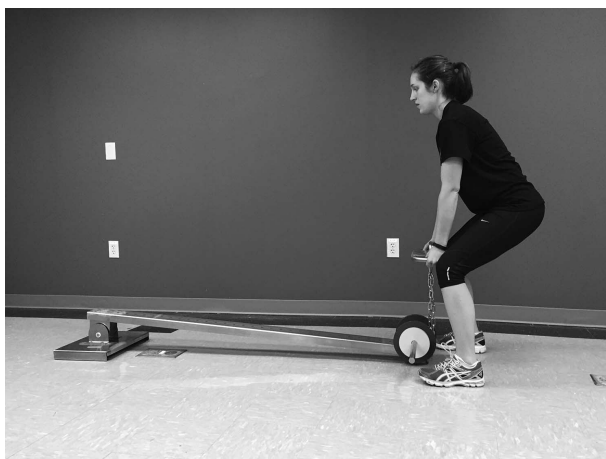


FIGURE 3
XRTS lever arm start position. Used with permission.



FIGURE 4
XRTS lever arm end position. Used with permission.

10-point modified RPE scale specific to this study (see Table 1) was also used to determine perceived exertion with each lift attempt.

Procedures

Subjects viewed a video that outlined the proper techniques for performing the lifts using the crate

or the XRTS Lever Arm, depending on the lift they were performing. In addition, a single investigator using a standardized script described and demonstrated the lifts (see Table 2). The subject's lifting techniques were not critiqued in any way after the initial demonstration.

On the first day of testing, a 1RM was established for subjects performing a crate lift from 20 in. off the ground to their navel (see Table 3). Unmarked weights were placed symmetrically in the crate with reference to the center of the crate, in line with the sagittal plane of the lifter, and were used to increase the weight depending on the percentage of the subject's self-described maximum. After 1RM was determined for the crate lift, the subject was then randomly assigned five weights using a random number generator (iRandomizer Application) ranging from 10% to 100% of his or her determined 1RM and asked to give a rating of his or her RPE after each lift. Before each lift, the subject stood behind a curtain partition to blind him or her to the amount of weight in the crate. Once the investigator had the appropriate weight placed in the crate for each lift, a covering was placed over the weights that were in the crate. Before lifting, the investigator read the verbal instructions for the crate lift (see Table 2). The subject repeated the same procedure used for the crate lift 2–5 days later using the XRTS Lever Arm (see Table 3). After 1RM was determined for the XRTS Lever Arm lift, the subject was then randomly assigned to the same five weight options identified for the crate lift and asked to give an RPE after each lift.

Data Analysis

Forty-eight subjects were recruited for this study; 44 females completed this study, and four subjects were excluded from this study because they were able to lift more than 100 lb. Descriptive statistics were used to report age, gender, height, and weight of the subjects who participated in the study (see Table 4). The weight and RPE of each subject's lift were collected

TABLE 1
Rate of Perceived Exertion 10-Point Modified Scale

Rating	Description
1	Very light
2	Fairly light
3	Moderate
4	Somewhat hard
5	Hard
6	
7	Very hard
8	
9	
10	Very, very hard (maximal)

TABLE 2
Verbal Instructions for Crate and Lever Arm Lifts

Crate lift: "We want to determine your maximum safe lifting capacities. I am going to demonstrate how we would prefer for you to lift. However, if your lifting mechanics are not what would be considered 'ideal,' I will not interfere by correcting you. Assume the proper position by moving close to the workload, bending at the waist, knees, and ankles and firmly grasping the handles of the crate. It is OK to bend at the waist to get into the correct position to lift. But when you begin to lift, I want you to have your rear end down and your chest up as far as you can reasonably go to maintain proper position of the low back. If you feel any pain or significant discomfort during any of these lifts, I want you to immediately return the workload to its starting point. Do you have any questions?"

Lever Arm lift: "We want to determine your maximum safe lifting capacities on this testing device. I am going to demonstrate how we would prefer for you to lift. However, if your lifting mechanics are not what would be considered 'ideal,' I will not interfere by correcting you. Assume the proper position by moving close to the workload, bending at the waist, and firmly grasping the handles of the lifting plate. Align the center of your wrists with the handle that is on top of the handle plate. It is OK to bend at the waist to get into the correct position to lift. But when you begin to lift, I want you to have your rear end down and your chest back as far as you can reasonably go. If you feel any pain or significant discomfort during any of these lifts, I want you to immediately return the workload to its starting point. Do you have any questions?"

TABLE 3**Baseline Protocol for Establishing 1RM With Lifting Crate and XRTS Lever Arm**

Initial assessment for crate: Crates were stacked evenly over one another so that the handles of the top crate were at a height of 20 in. The initial assessment began by assessing lifting capacity with two unmarked bars in the crate. After each lift, the subjects were asked to estimate the percentage of their own personal maximum they believed the workload represented, e.g., 20% of their maximum, 45% of their maximum, etc.

Initial assessment for XRTS Lever Arm: Chains attached to the lever arm handles are positioned so that when pulled taut, the handles were at a height of 20 in. Begin by assessing lifting capacity with the unloaded lever arm at position marked "35." After each lift, the subjects were asked to estimate the percentage of their own personal maximum they believed the workload represented, e.g., 20% of their maximum, 45% of their maximum, etc.

0%–30%: Workloads increased by adding unmarked weight to the crate/lever arm for each successive lift until at least 30% of the subject's self-described maximum was attained.

30%–60%: Subsequent to attaining at least 30% of the subject's self-described maximum, workloads increased by adding unmarked weight to the crate/lever arm for each successive lift until at least 60% of the subject's self-described maximum was attained.

60%–90%: Subsequent to attaining at least 60% of the subject's self-described maximum, workloads increased by adding unmarked weight to the crate/lever arm for each successive lift until at least 90% of the subject's self-described maximum has been attained.

90%–100%: Subsequent to attaining at least 90% of the subject's self-described maximum, workloads increased by adding unmarked weight to the crate for each successive lift until the subject describes any lift as a "one-time safe maximum level of lifting" or subject's "100%" self-described maximum. In either case, it was confirmed with the subject that his or her "maximum safe" was attained.

100%: If the subject was ambivalent regarding the attainment of "100%" (or "maximum safe"), the subject was asked whether he or she would like to try another lift with the addition of a single unmarked weight added to the workload. If the subject did not, lifting activities were discontinued.

and used in subsequent analysis. The independent variable of this study was the subjects and the dependent variable was the weight of the 1RM. Paired *t* tests were used to compare maximal lifts between subjects. Spearman's correlation coefficient was used to determine the relationship of perceived exertion between the XRTS Lever Arm lift and the crate lift. For all statistical testing, α was set at less than .05.

RESULTS

There was a statistically significant difference ($p < .04$) between maximal lift values for the two lifting modes. The percent difference between the crate lift and the XRTS Lever Arm lift was $10.5\% \pm 6.4\%$, with values ranging between 0.82% and 23.78%. Of the 44 subjects, 38 subjects were below a 20% difference and 31 subjects were below a 15% difference. The current criteria for the XRTS Lever Arm lift and crate lift comparison indicate a valid effort if there is less than 30% difference for a single-lift comparison and a majority of multiple-lift comparisons less than 25%. In this study, the percent difference between the two modes of lifting meet current criteria for single-lift comparisons. The results of the comparison between the XRTS Lever Arm lift and the crate lift with multiple days between testing

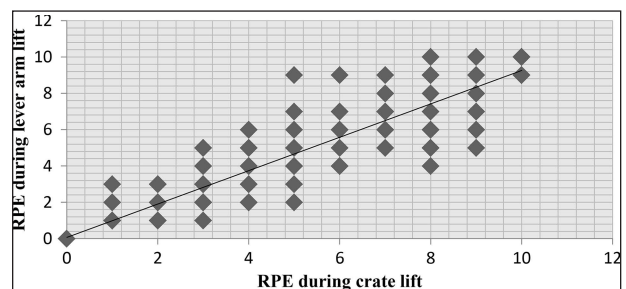
sessions indicate that reproducible maximal lifting on different days can occur. In addition to reproducible dynamic lifting capability between the two modes of lifting, there was a positive correlation between the RPE on the crate lift and the XRTS Lever Arm lift, $r = .92$ (see Figure 5). This indicates that subjects were able to reproduce similar maximums, with dynamic lifting beginning at 20 in. from the floor to waist level on separate days.

IMPLICATIONS FOR CASE MANAGEMENT PRACTICE

Research regarding distraction-based testing is limited to only two published studies using the XRTS Lever Arm and crate lift comparison. Both of these studies used comparisons on the same day, one with patient undergoing an FCE and another with asymptomatic controls performing both modes of lifting on the same day. To the authors' knowledge, no other existing studies report investigating the reproducibility of maximal lifting with two different modes of lifting on two different

TABLE 4**Demographic Information of Subjects ($n = 44$)**

	<i>M</i>	<i>SD</i>
Height (in.)	65.55	3.49
Weight (lb)	144.55	22.62

**FIGURE 5**

Correlation of RPEs during crate lift and XRTS Lever Arm lift. RPE indicates rate of perceived exertion.

Comparisons between demonstrated lifting ability during the treatment process and the results of the FCE may occur by the case management team. This practice is reflective of the philosophy and guiding principles as outlined in Standards of Practice for Case Management by the Case Management Society of America.

days. Comparisons between demonstrated lifting ability during the treatment process and the results of the FCE may occur by the case management team. This practice is reflective of the philosophy and guiding principles as outlined in Standards of Practice for Case Management by the Case Management Society of America (2016). Having a measurement of reference of functional capabilities on separate days with two modes of lifting will allow case managers to use evidence-based decision-making.

An FCE is typically ordered after the completion of physical rehabilitation and before releasing a patient to full or modified duty. In addition to assessing the ability to function within normal job demands, an assessment of effort by the injured worker typically takes place. Case managers and physicians make comparisons between functional lifting abilities displayed during treatment sessions and the FCE. These comparisons may often take place with the subpoena of medical records and may be discussed during the deposition or trial process. If an FCE takes place at a different facility than the physical therapy or work conditioning treatment, two different modes of lifting may take place based on the equipment within each facility. To the authors' knowledge, no investigations have taken place regarding the dynamic lifting capability on separate days using two different modes of lifting. Prior to this study, the expected reproducibility of dynamic lifting with two different modes of lifting on two different days was unknown. The use of the asymptomatic/nonpatient population in this study allowed for the investigation of the physical capability and perceived difficulty of performing dynamic lifting on separate days with two different modes of testing. The results of this study indicate a mean difference of 10.46% \pm 6.41% between the two separate days of testing

and similar RPEs for similar workload with the two different modes of lifting. Therefore, there should be some expected differences between comparisons on separate days (potentially during treatment and the day of the FCE). The results of this study can be used as a reference to percent differences for comparison with injured worker's abilities measured on separate days. The results of this study indicate up to 23% differences in absolute workloads lifted on separate days. The authors of this study do not believe these results should be used as a validity criterion comparing results on different days.

Documentation of lifting activities during treatment can be used to cross-reference the results of objective lifting activities in the FCE. Accurate knowledge of the injured worker's effort during functional testing in treatment and in the FCE is essential for making evidence-based decisions on case management. Inaccurate methods of assessing sincerity of effort may mislead the case management team to interpret the results of an FCE as a valid measure in determining whether the patient can return to work when the injured worker gave a submaximal effort. Typically, different equipment is used for lifting activities during treatment compared with the equipment used during the FCE. The reason for utilizing different modes of lifting between treatment and the FCE is that it minimizes the injured worker's familiarity with testing equipment that is used in establishing sincerity of effort for return-to-work evaluation. The results of this study indicate that individuals are able to reproduce demonstrated maximal lifting with two different modes of lifting on different days. These percent differences between two different modes of lifting fall within criteria for a valid effort when using the crate lift and XRTS Lever Arm comparison (St. James et al., 2010; Townsend et al., 2016).

Accurate knowledge of the injured worker's effort during functional testing in treatment and in the FCE is essential for making evidence-based decisions on case management. Inaccurate methods of assessing sincerity of effort may mislead the case management team to interpret the results of an FCE as a valid measure in determining whether the patient can return to work when the injured worker gave a submaximal effort.

No single-lift comparison should be 30% or more in order for effort to be classified as valid during an FCE (St. James et al., 2010). Existing criteria for the crate lift and XRTS Lever Arm lift comparisons have classified valid efforts with no false-positives in a control study (Townsend et al., 2016). This control study made three to five comparisons between the crate lift and the lever arm lift during an XRTS FCE (Townsend et al., 2016). There were no differences in the subject's ability to pass existing validity criteria for effort when comparing the crate lift with the XRTS Lever Arm lift on the same day or with multiple days separating the comparison (Townsend et al., 2016). It should be noted that previous research on the existing validity criteria for the two modes of lifting is intended for comparisons to be made within the same calendar day during an FCE (St. James et al., 2010; Townsend et al., 2016). The results of this study had percent differences between crate and lever arm lifting between 0.82% and 23.78%. These measures were taken on different days opposed to the two modes of lifting occurring on the same day as during an FCE. Despite these measurements being taken on different days, the observed differences in the crate lift and XRTS Lever Arm lift comparisons meet current validity criteria for a valid effort with a single-lift comparison. Expected reproducibility of reported maximal lifting capabilities with asymptomatic subjects should meet existing validity criteria regardless of the comparisons are made on the same day or different days.

Limitations

Limitations of this study included a small sample size and a lack of control in the environment and behaviors of the subjects that occurred outside data collection between the crate lift and lever arm days of testing. For example, diet, sleep, and perceived stress were not logged between the testing days. However, these elements are also unable to be controlled with patients between the last day of treatment and the FCE. The use of asymptomatic subjects was necessary to determine the physical ability to reproduce dynamic lifting maximums without the influence of physical pain or psychosocial factors that exist in injured workers (Gross & Battié, 2005; Li-Tsang, Chan, Lam, Lo-Hui, & Chan, 2007).

Future Research

Future research on comparisons between the crate lift and XRTS Lever Arm lift will need to include a larger sample size with a mix of both males and females in order to confirm the findings in this study. In

addition, future research with distraction-based testing can include investigation of potential behavioral or physical components that influence effort assessment results. The specific effect of variables such as physical discomfort or psychological stress in a control population would be beneficial. Continued investigation will allow for appropriate interpretation of test results when the assessment of effort occurs.

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