THE EFFECTS OF FEEDBACK IN ISOKINETIC DYNAMOMETRY

EFFECTS OF VISUAL FEEDBACK AND VERBAL ENCOURAGEMENT ON PEAK TORQUE AND TOTAL WORK VALUES IN KNEE EXTENSORS TESTING.

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ABSTRACT

The purpose of this study was to examine the effects of visual feedback and verbal encouragement on peak torque and total work measurements during maximum isokinetic concentric activation of knee extensors.

Twenty-seven healthy male subjects between the age of 19 and 42 completed the two test sessions 14 days apart using an isokinetic dynamometer at 60°/s and 450°/s. Visual feedback was provided as real-time display of the moment output. Verbal encouragement was done using a standardised procedure. With visual feedback and verbal encouragement peak torque and total work at both speeds were significantly greater than without.

These findings suggest that combined visual and verbal encouragement are strong motivating factors. It is therefore recommended to use feedback and verbal encouragement as part of a standardised procedure during isokinetic testing.

INTRODUCTION

The concepts of isokinetic evaluation, conditioning and rehabilitation have been widely accepted since their introduction to the medical field. Today an increasing number of rehabilitation centres and sports clinics utilise highly sophisticated isokinetic testing and rehabilitation devices (Cybex, Kincom, Biodex) on a daily basis.

Since the concept of isokinetics was first described by Hislop and Perrine in 1967[1] a series of highly sophisticated devices have been available on the market for dynamic muscle testing. Isokinetic testing has been found to be both a reliable and valid method of objectively recording muscle function[2,3,4]. Although isokinetic dynamometers have become standard equipment in rehabilitation clinics, determining the most effective protocols for testing and rehabilitation are still an active area of research[5,6,7].

Standardised guidelines for the use of isokinetic devices are lacking. Manufacturers do not provide detailed guidelines on how to proceed in order to use the option for visual feedback and verbal encouragement. Most of the research studies where isokinetic testing is used do not mention whether visual feedback and verbal encouragement were used.

Research in this area has received limited attention over the years. Few studies have investigated the effects of visual feedback on the test results. We were not able to find published research studies that have investigated the effect of verbal encouragement alone in isokinetic testing. Hulten *et al*[8] utilised visual feedback to guide subjects to perform at a certain fraction of maximal isokinetic torque. No data were reported on the efficiency of the method used. A study by Peacock *et al*[9] used isometric knee extension peak torque's between groups watching the torque dial and a control group not receiving visual feedback. No statistically significant differences were reported. Visual, plus verbal encouragement did produce significant strength increases as found by Fignoni *et al*[6].

They found higher strength and fatigue value in isokinetic knee extensor and flexor testing but only for slow speed testing 30°/s. No difference was recorded during high speed 300°/s. The superior quality of the slow speed knowledge of results was explained by the longer time to utilise the visual feedback. Hald and Bottjen[5] used sub-maximal contractions attempted at 50% of maximum peak torque of quadriceps and hamstring muscle groups. Peak torque at both speeds 60°/s and 180°/s was significantly greater in both muscle groups. In a more recent study Kellis and Baltzopoulos[7] studied the effects of visual feedback on peak torque values during isokinetic eccentric activation. These investigators used angular velocities of 30°/s and 150°/s. The results showed an 8% increase in peak torque values when visual feedback was used.

The purpose of this present study was to investigate the effects of visual feedback combined with strong, aggressive verbal encouragement's on isokinetic torque and total work production.

METHOD

Twenty-seven male subjects between the ages of 19 and 42 years participated in this study. All subjects had a right dominant lower extremity. None of the subjects had any history of lower extremity joint injury, surgery, or disease. Furthermore, no subject had any cardiac condition nor had they participated in professional, semi-professional, or high level sports. The mean, standard deviation and range of subject age, height and weight are shown in Table I. Subjects wore similar clothing and identical footwear during the two test sessions and were asked not to alter their physical activities between the two sessions.

Table I. Mean, standard deviation and range of age, height and weight of subjects

	Mean	SD	Range
Age	27	7.03	19 – 42
Weight (Kg)	67	10.03	49 – 98
Height (cm)	170	7.97	155 – 188

PROCEDURE

Two test sessions were administered to each subject. The sessions were held on the same day and same time, two weeks apart. During each test sequence, half the group did the test with visual feed back and verbal encouragement whereas the monitor was blank and no verbal encouragement was given for the rest of the group. The procedure was reversed during the next test session. It was also deemed important to limit the time between the test sessions to reduce the effect of uncontrollable factors that may cause changes in the subject. At the beginning of the first session, informed consent was obtained and each subject's age in years, height in cm and weight in kilograms were recorded. Lower extremity dominance was determined by kicking a ball placed on the floor[10]. All peak

torque and total work tests were administrated by the same investigator (AS) using a Biodex isokinetic (Biodex Corp., Shirley, NY) dynamometer. This system permits isolated joint exercise and testing at a preset, constant angular velocity. It measures the subject's exerted force as torque. For each test session, the concentric/concentric isokinetic mode was used. All settings remained constant throughout the study. The system was interfaced to a PC compatible computer. Subjects were randomly assigned to one of the test groups eg. visual feedback and encouragement (VFBE) or non-feedback (NFB).

On the first test day, descriptive data were collected and subjects were familiarised with the apparatus and testing protocols. In each test session, subjects were seated on the dynamometer (double chair model). The axis of the dynamometer was visually aligned with each subject's dominant knee joint axis and the input lever arm adjusted and secured to the distal lower leg. Vertical and horizontal positions of the dynamometer, lever arm length and chair positions were recorded to provide identical alignment for both test sessions.

Stabilising belts were placed across the subject's chest, pelvis and thigh of the dominant lower extremity. Subjects were instructed to cross their arm over their chest and hold on the straps during testing to provide additional stabilisation. A warm-up of five minutes was conducted on a bicycle ergometer at 60 rpm, then gradually increased to 90 rpm while maintaining a constant work level.

The subjects then performed five to ten sub-maximal repetitions. This allowed the subject to "get used" to the speed of movement at each pre-set angular velocity[3]. Standardised instructions were read by the investigator before each test. The VFBE group was shown printouts of the screen that they would see and informed to watch the highest point of the curve and to try to increase the highest level for each repetition. The verbal encouragement was done in a standardised way. Aggressive verbal commands and encouragement were given by the same investigator.

The tests consisted of five consecutive, reciprocal contractions of quadriceps and hamstrings beginning from a starting position of approximately 100° knee flexion, to full extension, and return to the starting position. Low speed recording (60°/s) was done first, followed by five minutes rest. High speed testing (450°/s) was done at the end.

The same procedure was used 14 days later with and without feedback respectively. As mentioned earlier, half the subjects were assigned to either group randomly in the beginning, and the procedure was reversed at the second testing.

Subjects were encouraged to direct their attention away from other irrelevant information sources and to concentrate entirely on the monitor.

DATA ANALYSIS

Isokinetic data were obtained from the Biodex computer software. (3.2, Biodex Corp., Shirley, NY).

The peak torque of each exercise set was measured in Nm. Total work was computed as the sum of all work performed during one exercise set i.e. five repetitions. Comparison between the test sessions with and without visual feedback was done using a three factors repeated measures ANOVA.

Each subject was acting as his own control. The level of significance was set at $p<0.05$. The moments were corrected for the effects of gravity. The maximum moment from any of the five repetitions was used in the analysis. Statistical analysis was performed for both peak torque and total work for speeds of 60°/s and 450°/s.

RESULTS

The mean values and statistical comparison of the two test sessions for the entire sample are found in Table II. A three factor repeated measures ANOVA-test revealed significant differences ($p<0.05$) between the group that had visual feedback and verbal encouragement and the non-feedback group. The differences were significant at both high and low speed. Also total work performances revealed significant differences at both speeds. The average maximum moments of knee extensors at 60°/s and 450°/s with verbal encouragement and visual feedback were 8% and 13% higher than the NFB moments respectively. Similarly, the mean total work results indicated 15% and 17% higher values during VFBE than during NFB.

Table II. Mean values and statistical comparison of feedback (F) and non-feedback (NF) in relations to peak torque and total work

	Speed 450°/s			Speed 60°/s		
	t-value	df	p-value	t-value	df	p-value
Difference between F & NF						
Peak Torque	3.64	15	0.002	3.32	26	0.003
Total Work	3.16	15	0.006	2.06	26	0.049

DISCUSSION

Verbal encouragement is probably more likely to stimulate a maximum effort during any kind of strength assessment or performance[11]. The degree to which verbal encouragement is responsible for higher performances remains unexplained. Rube and Secher[12] indicated a paradoxical influence of encouragement on muscle fatigue. However, the testing procedures used were different from what one uses in modern rehabilitation settings.

Our study is the first to explore the influence of both verbal encouragement and visual feedback during isokinetic testing simultaneously. While the results of our study are consistent with a recent study by Kellis and Baltzopoulos[7], the latter study did not use verbal encouragement as a variable. Only visual feedback was used. Also Kellis and Baltzopoulos[7] used eccentric muscle work whereas our work was done with concentric activation. Our study also indicated a significant increase in total work which means that not only peak performances are increased but an increase occurred during all the repetitions.

The results of our study and from Kellis and Baltzopoulos[7] study are partially in contrast to previous studies by Hald and Bottjen[5] and Fignoni and Morris[6]. These authors reported no effect of visual feedback during assessment at high speeds of 180°/s and 300°/s. Visual information requires about 190-260 msec to be processed by the central nervous system, depending on the task constraints[14]. It was postulated that time required to process information from the display during high speeds was too short. In addition, the reciprocal nature of fast speed isokinetic testing demanded that secondary task be performed during the post feedback period ie. during the flexion part of the cycle. In the present study, the subjects were asked to concentrate entirely on one part of the cycle (extension) only. Not only did we find an increase in peak torque and total work during high speed testing but the differences were larger than during low speed testing.

The possible reason for this important difference in test results between both studies could be the use of different instruction protocols given to the subjects before the tests ie.

to concentrate on extension only in our study. Another factor affecting the results could be the nature of muscle contraction which was used ie. concentric versus eccentric contractions.

The effect of standardised aggressive verbal encouragement is less likely to be responsible for the differences in results because during low speed testing results were similar in both studies. Further research is needed to elucidate the importance of concentric or eccentric muscle contractions in VFBE or NFB isokinetic dynamometry.

The limited research that is done on the use of feedback to obtain strength improvements has given variable findings. Our study suggests that visual feedback combined with standardised verbal encouragement is a strong motivating factor for the maximum muscular moment and total work output during concentric activation.

CONCLUSION

A procedure of visual feedback and standardised verbal encouragement was incorporated into a concentric isokinetic test of the quadriceps muscle group using normal male subjects. Peak torque and total work output at both low 60°/s and high 450°/s speed increased significantly under visual feedback and verbal encouragement conditions in comparison to groups where no feedback was provided. The inclusion of verbal encouragement in a protocol is an important factor to consider when testing or rehabilitating patients on isokinetic devices. Our results suggest that VFBE should always be implemented during isokinetic dynamometry especially in these test- and rehabilitation settings where maximum performances are required.

Manufactures of isokinetic testing devices should include standardised visual feedback and verbal encouragement protocols in their manuals in order to obtain optimal testing and rehabilitation results. This may prove valuable for clinicians using isokinetic devices.

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