The Effect of No Intervention, Visual Biofeedback, and Verbal Encouragement on Isokinetic Knee Peak Torque

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ABSTRACT

The purpose of the study was to assess the effect of various protocols upon peak torque of the knee flexors and extensors using a biodex system II isokinetic, to support or suppress its use with some neurological cases, especially those with visual or auditory disorders. Twenty-four healthy male (ages 20-31 years) were recruited from national club members to perform three sets of five maximal concentric repetitions of the knee flexors and extensors at 60° per second. Peak torque was measured to assess whether different protocols could result in variations. Essentially the protocol was standardized, with the only variation being the encouragement given; (i) no intervention, (ii) visual biofeedback, and (iii) verbal encouragement. One-way ANOVA test revealed no significant differences between the mean of each group ($p>0.05$). However, means were seen to vary slightly (not more than 8.8%). Results showed no significant differences between different protocols, a finding that can indicate that experiments employing dissimilar protocols could be comparable. Error resulting from protocol variation is not significant, allows the use of isokinetic equipment with neourological patients complaining from combination of symptoms including visual or auditory problems. The biodex system II dynamometer has been shown to be a reliable piece of equipment and sensitive enough to be used with neurological cases even those with lack of visual or auditory feedback.

Key words: *Isokinetic, visual biofeedback, verbal encouragement.*

INTRODUCTION

The visual and auditory inputs are essential cues for physical therapy management. Their pathways are commonly affected in many neurological conditions. Their affection constitutes one of the major delimitating factors for assessment and treatment. The aim of this study was to find out certain physical therapy modality that is applicable for various neurological disorders and not affected by visual or auditory feedback.

Isokinetic dynamometers have become a commonplace piece of equipment used by rehabilitation therapists. Due to its flexibility, it has varied uses as an objective measuring, assessment, training and research tool. Recently it has been used with some neourological patients (Sharp and Brouwer 1997, Engardt et al. 1995). Although the test-re-test reliability has been proven for the most major joints, little work has been performed to compare different protocols and their outcomes. Isokineic dynamometers, since their introduction into the clinical setting, have increased the objectivity in the assessment of neuromuscular and musculoskeletal functions, which are essential in rehabilitation, and the development of strength (Baltzopoulos et al. 1991 and Thistle et al.1967).

The advantages of isokinetic dynamometers over other forms of testing come in two categories. Firstly, they have accommodating resistance: whereby the resistance of the machine is varied by a feedback mechanism to equal that of the force applied to it by the limb being tested (Morrisey et al. 1995). Secondly, the velocity of the rotating motion is constant (pre-set by the tester) allowing the speed of contraction to be controlled (Walmsley and Pentland 1993). Using accommodating resistance ensures the torque curve produced by the muscle, or group being tested is always maximal throughout the entire range of movement (ROM). Therefore providing the most efficient means of strength training, as the muscle(s) is always worked maximally (unlike free weights), although previous studies have failed to show this (Smith and Melton 1981). In rehabilitation accommodating resistance has its advantages, whereby a decrease in peak torque due to pathology or pain is accommodated and the force reduced accordingly (Bazopoulos and Brodie 1989). The ability to control the speed of muscular contractions allows a specific muscle fiber type to be tested, stop high-speed muscular contraction that may be damaging to rehabilitation or simulate functional activities. Further advantages such as being able to limit the ROM in which the contraction occurs also helps to make this a useful tool in rehabilitation of specific conditions.

Indeed, Skovly (1980) stated that isokinetic dynamometers "were an essential piece of equipment in rehabilitations". The effect of the patients being able to work maximally throughout their full range of movement, unlike any other form of training except manual proprioceptive neuromuscular facilitation (PNF), makes it an ideal treatment tool. The increased use of these machines is indicated by the amount of articles published were over 2000 (Zuluga 1995 and Gleeson and Mercer 1996).

To date research has proved high test-retest reliability for these machines, although most studies have been concentrated on either the knee or the shoulder (Frisello et al. 1994, Li et al. 1993) with reliability values ranging from 0.76- 0.97 (Frisiello et al. 1994, Feiring et al. 1990). Although their use is widespread in research, sports medicine and physiotherapy department, protocols have varied dramatically with the complete method of testing are rarely defined (Nitschke 1992).

The variation in protocols, occur due to differences in number of repetitions, rest between repetitions and sets, type of encouragement and feedback given, speed and type of contraction (eccentric, concentric of isometric) and type of dynamometer used (Keating and Matyas 1996).

The use of feedback given to the subject during testing is a common difference between protocols. Many types of feedback can occur from verbal encouragement. Reporting of these different variations within protocols has been limited, and studies carried out have not included all information on protocols so comparisons between these studies are difficult.

Different authors have investigated the use of visual feedback since (1983) when Riggsby put forward the hypothesis that it would enhance muscular contraction. Notably, Figoni and Morris (1984) found a 12% increase in torque; Balzopoulos et al. (1991) found an increase of 8% (hamstrings) and 6% (extensors) whilst Hald and Bottjen (1987) found a 6% differences. The use of verbal encouragement has been less well documented and Peacock et al. (1981) found that when associated with visual feedback it resulted in significant differences in peak torque, however visual feedback or verbal encouragement singularly had no effect.

Although, obviously there are multitude of variations that can occur in protocols all cannot be addressed in one study. Therefore, the aim of this study was to assess the impact of using different types of encouragement during a standardized testing regime on the knee flexors and extensors at 60° per second (deg/sec) and compare them against a "baseline" measurement of no encouragement with the same test, in order to document if it is a reliable piece of equipment and sensitive enough to be used with some neurological cases that might have different associated combination of affection, especially those with visual pathway affection as multiple sclerosis, neuromyelities optica, syphilitic mengities, temporal lobe and pituitary tumors, and lesion of posterior cerebral arteries or those with auditory pathway affection as vascular and neoplastic lesion of brainstem, syringobulbia, vertebrobasiliar insufficiency, vestibular neuritis, Menier's disease and labyrinthities (Rudge 1982, Compston et al 1978 and Walton 1993).

METHODS

Equipment

Isokinetic measurements were made on a biodex system II isokinetic dynamometer (Biodex, Shirley, New York USA).

Recruitment and induction

Healthy male subjects (n=24; ages 20-31 years) were recruited from national club members. Potential subjects were screened for knee pathology, current pain, trauma, medication, heart or neurological disabilities and diabetes mellitus. Any one who fulfilled the above criteria was excluded from the study. A verbal and written outline of the study was given to the subject prior to participation, the subjects were then reminded of their right to withdraw from the study at any time. They volunteered to perform concentric exercises of the left and right knee flexors and extensors using various protocols on an isokinetic dynamometer. The subjects were randomly allocated into one of three groups. Volunteers were randomly allocated a subject number of 1-24; each of the subject numbers had been given an order in which the protocols were to be administered. To all subjects the three separate protocols were administered in a sequence where there was no repetition of the ordering, thus limiting bias that may have occurred due to order effect.

Measurement procedure

Subjects were seated on the isokinetic dynamometer with the back rest position at 15 degrees reclined from the vertical seat base positioned 25mm proximal to the posterior aspect of the knee. Subjects were fastened in this position using the straps provided (left and right shoulder and waist straps) to reduce "trick" or accessory movements. Subject's knees were placed into 90° of flexion and the lateral epicondyle was marked. The knee was secured in position using the thigh support provided. The axis of the dynamometer was aligned with the mark on the lateral epicondyle. The (left or right) knee attachment was then placed on the output shaft of the dynamometer and adjusted so that the attachment was set at its position. The knee attachment was secured to the limb using the Velcro straps provided. The range of movement was then set from 0° (full speed of the dynamometer was set at 60° per/sec. Subjects then completed a 10 minutes warm up phase. The warm up period consisted of four sets of 10 sub maximal contractions at 50% of the subject's maximum with 30 seconds rest was allowed between sets. Testing then began; the subject was asked to complete five maximal reciprocal concentric contractions (knee extension followed immediately by knee flexion) of the first protocol. After three minute rest the second protocol was completed, followed by the final set, after five minute pause the opposite leg could be tested with the exact sequence after warm up.

Testing Protocols

I) No intervention

Subject were asked to fold their arms across their chest and upon the word "Go", to work as hard and fast as they could extending and flexing their knee for 5 maximal repetitions.

II) Visual biofeedback

During the extension and flexion visual encouragement was given by real time feedback of the peak torques (the actual curve produced on the monitor) produced by individual were left on the screen to act as a stimulus for the next contraction.

III) Verbal encouragement

Verbal encouragement was given at a "moderate" level encouraging them to "PUSH" during knee extension and "PULL" during knee flexion.

Data collection and Analysis

Data was "windowed" by the use of Biodex advantage computer software to eliminate artifacts and torque overshoot. Peak torque was measured as the highest point on the torque curve (no matter at what angle it occurred for both knee flexors and extensors). Data was then analyzed using one-way ANOVA; significance was accepted at a level of $p< 0.05$. Analysis of data was also performed using the "no intervention" protocol as baseline, and expressing all subsequent protocols as percentage difference from this baseline reading.

RESULTS

Results are shown in fig. 1-3, and recorded in tables 1-2 (means ± s.d. of percentage difference from baseline "no intervention" as appropriate). Using one-way ANOVA no statistical differences were seen between protocols ($p>0.05$) for either (left or right) of the knee flexors or extensors (see table 1). Differences could however be seen whereby baseline (no intervention) measurements were repeatedly the lowest, with visual biofeedback registering higher levels as shown in Fig.; (1) quadriceps, Fig.; (2) hamstring, Fig.; (3) average of left and right quadriceps and hamstrings.

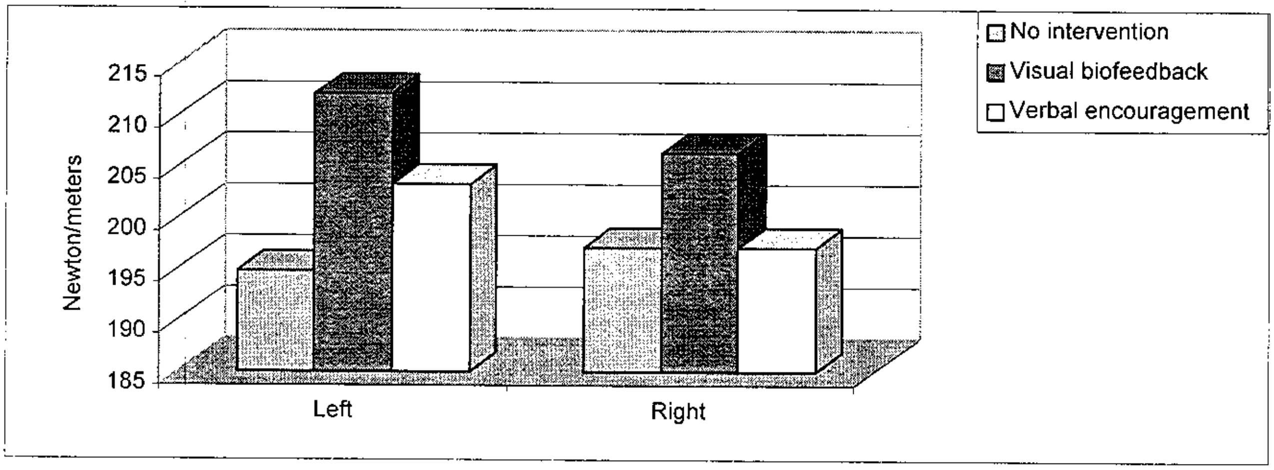

Fig. (1): Shows the mean peak torque values for the left and right quadricps.

This was indicated more clearly when means were expressed as a percentage difference from baseline recordings. Variations were observed with up to 8.8% increase in torque over baseline levels (see fig. 1-3).

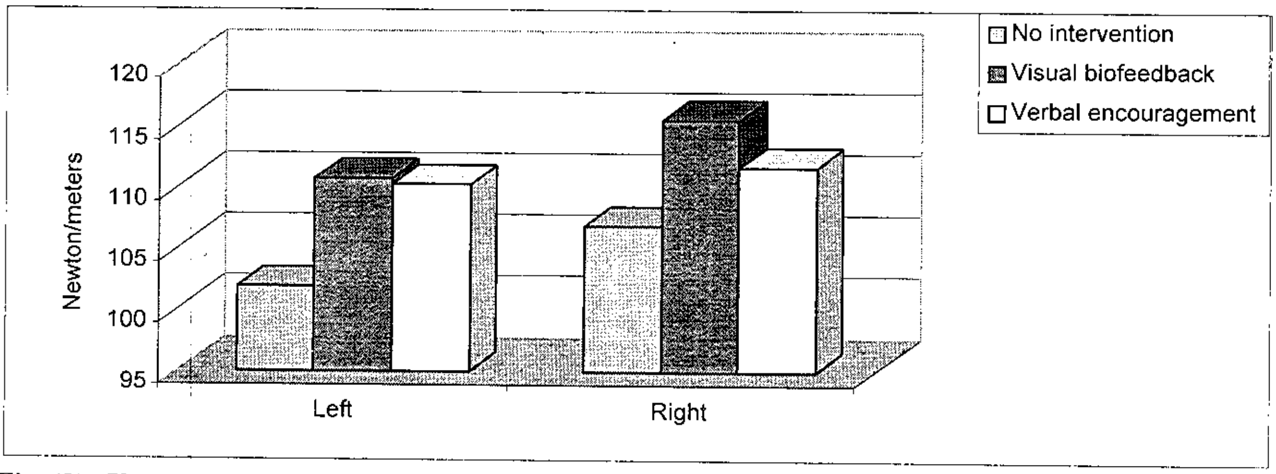

Fig. (2): Shows mean peak torques values for left and right hamstrings.

Greatest increases were seen in the biofeedback group with the verbal encouragement group indicating smaller changes.

Larger increases were seen in the left leg compared with the right as shown in table 2. Table 2. also indicates average differences for left and right legs for quadriceps and hamstrings.

As there are no significant differences between groups the null hypothesis was accepted therefore the use of feedback did not result in significantly greater peak torque production of the knee flexors and extensors than with no encouragement. With regards to comparing peak torque production to the hamstring and quadriceps to no encouragement, the null hypothesis was also accepted.

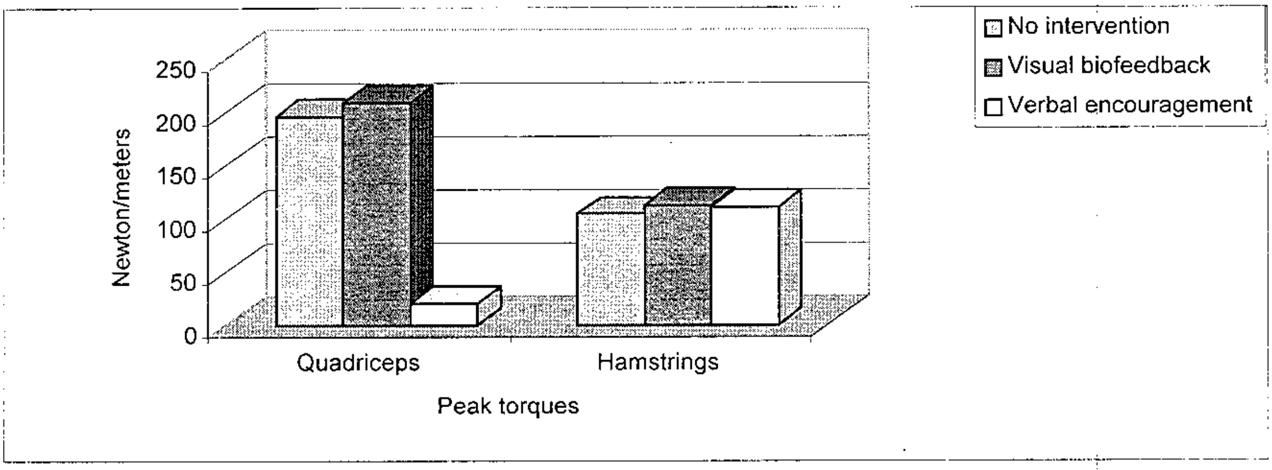

Fig. (3): Shows mean peak torques values for the avage of quadriceps and hamistrings.

	Quadriceps			Hamstrings		
	Left	**Right**	**Average**	**Left**	**Right**	**Average**
No intervention	194.9	197.1	196.0	101.9	106.9	104.4
Visual biofeedback	212.1	206.3	209.2	110.7	115.5	113.1
Verbal encouragement	203.2	197.2	20.2	110.2	111.6	110.9
F Value	1.154	0.332	0.698	0.836	0.573	0.761
P Value	0.332	0.802	0.556	0.478	0.634	0.519

Table (2): The Percentage of the difference from baseline (no intervention), for different protocols (positive unless indicated).

	Quadriceps			Hamstrings		
	Left	Right	Average	Left	Right	Average
No intervention	0%	0%	0%	0%	0%	0%
Visual biofeedback	8.8%	4.7%	6.7%	8.6%	8.0%	8.3%
Verbal encouragement	4.3%	0.1%	2.1%	8.1%	4.4%	6.2%

DISCUSSION

The aim of this study was to ascertain if differences in peak torque occurred in a population of normal subjects when testing protocol using an isokinetic dynamometer was manipulated (i.e. varying the methods of encouragement). The subjects completed protocols in a sequence, which ensured that the same order was never repeated, thus limiting bias. Speeds of 60 deg/sec were used, as at speeds less than this auto-inhibition can occur during isokinetic knee testing (Davies 1984). Rests of three minutes were given between sets in the research done by Robinson et al. (1996). Their results indicated that this was a long enough recovery time between sets and gave an excellent test-retest reliability (r=0.86-0.96), whilst a warm up period allows for reliable peak torque readings and increased familiarity (Biodex 1995). The findings of the current study indicated that there was no statistical significance between groups. Therefore greater peak torque's can occur when subjects are given the correct motivation, as in agreement with Hald and Bottjen (1987) and Figoni and Morris (1984).

Visual feedback has a positive motivational effect on muscular response (Sapega et al.1992). Previous studies have looked at the visual influence on peak torque; results found in this study are lower than that found by Figoni and Morris (1984) whose increases were an average of 12% for hamstrings and quadriceps (at 15 deg/sec). The slow speeds used in his study may have resulted in these differences, as with decreasing speed of contraction, higher torques are produced, and this may ultimately influence the results found. However, the results indicated do compare with those found by Baltozopoulos et al. (1991) who found a 6% increase for flexion and 8% for extension whilst Hald and Bottjen (1987) found differences between 6.5- 10%. Figoni and Morris (1984) used healthy males, although their index of fitness was not indicated, Baltozopoulos et al. (1991) used habitually active males although once again no reference to level of sporting activity was indicated and Hald and Bottjen (1987) used male and female subjects who did not participate in high level sports, although this once again leaves a large area for subject inclusion. Why visual feedback has a motivational response has been studied by Newell (1981) and is thought to occur at a cognitive level, having a reaction and processing time. At the speed of 60 deg/sec
1500 msec (1.5 seconds) to complete, the reaction time to visual information is 160-180 msec (Schmidt 1982), therefore there would have been up to 1340 msec where information was available for information processing and response, and allowing the motivation for increased torque production. This may indicate that as the velocity of contraction increases the effects of visual feedback become less as the time allowed for processing reduces. This may also account for the large increases experienced by Figoni and Morris (1984), as with a reduced contraction speed more time would be available for processing the visual information and providing a response.

Verbal encouragement is commonly used in everyday use as a physiotherapist; the encouragement given and accepted can vary dramatically depending on the individual giving the encouragement and the person receiving it (Hargie et al. 1987). Peacock et al. (1981) found that verbal encouragement when coupled with visual feedback did produce greater peak torque levels, however singularly verbal encouragement made no significant difference. Results of this study indicates that increase torque production does occur, but less than visual biofeedback, this could be due to the type of verbal encouragement given.

The hamstring to quadriceps ratio at 60 deg/sec for the "no intervention (average of left and right)" group was 0.65, no variation was seen from baseline for the other groups, due to concomitant increases in both hamstrings and quadriceps. This is an agreement with the study by Baltozopoulos et al. (1991) whose quadriceps to hamstring ratio of 0.57, did not alter with feedback or speed (60 or 180 deg/sec) although other authors (Aagaard et al. 1995) have found that the ratio decreases with speed.

From this study, differences can be seen in peak torque production between different protocols, but these were not significant. Although comparisons cannot be inferred to a wider population without further research, these differences could obscure protocols in rehabilitation that did or did not have an effect, or on the testing of available maximal peak torque. It is therefore recommended when testing isokinetic peak torque that exact replication of protocols is used for each subject so that results can be compared and objective data obtained.

The insignificant differences between peak torques of different isokinetic exercise protocols of this study may be postulated to the integrity of the propioception, which substitute the visual or auditory feedback. In addition to this, the isokinetics depends to a great extent on the proprioceptive inputs for execution of movements during exercise performance.

Further research should therefore be directed at the combination of different types of feedback and the effects of protocols on specific neurological patients population.

CONCLUSION

The results of this study indicate that there was no statistical difference between the protocols used in this study. This difference in peak torque production by the use of separate protocols may, if the same person is tested by these protocols result in incorrect inferences being made about the subject. It therefore seems pertinent that this method of assessment is sensitive enough to pick up the improvement of neurological cases despite the different auditory and visual associated manifestations involved with the neurological abnormalities. This is true when exact replication of protocol made through out testing individuals, thus allowing data to be compared.

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الملخص العربي

دراسة مدى تأثير أقصى عزوم لعضلات الركبة باستخدام أجهزة الأداء الحركي في حالة، عدم وجود التغذية العائدة، وفي حالة وجود التغذية العائدة البصرية، وفي حالة وجود التغذية العائدة السمعية

تهدف الدراسة إلى اختبار تأثير وسائل التغذية العائدة من السمعية أو البصرية أو عدم وجود تغذية عائدة على قوة عزوم عضلات الركبة الأمامية والخلفية باستخدام أجهزة الأداء الحركي المقنن . تم اختيار ٢٤ فرداً متطوعاً لهذه الدراسة تتراوح أعمارهم بين ٢٠-٣١ سنة .

و قد تم قياس أقصى قوة لعزم العضلة الرباعية وكذلك العضلات الخلفية للركبة باستخدام ثلاثة طرق مختلفة من التغذية العائدة :

الطريقة الأولى : بدون استخدام أي وسيلة .
الطريقة الثانية : باستخدام التغذية العائدة البصرية .
الطريقة الثالثة : باستخدام التغذية العائدة السمعية .

وأثبتت النتائج عدم وجود أي فروق ذات دلالة إحصائية على أقصى قوة لعزوم العضلة الرباعية ذات الأربع رؤوس أو العضلة الخلفية للركبة باستخدام طرق التغذية العائدة المختلفة .

ولذلك نوصي باستخدام أجهزة الأداء الحركي المقنن في التقييم والعلاج في الأمراض العصبية المختلفة المصاحبة بإصابات سمعية أو بصرية نظراً لعدم تأثر الأداء الحركي بهذه الإصابات المصاحبة .