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ISOKINETIC PEAK TORQUE VS 1RM TESTS AS RELIABLE METHOD TO FOLLOW UP POWER DEVELOPMENT

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(Original scientific paper)

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Abstract

The objective of this research was to compare the isokinetic test for maximum peak torque and one-repetition maximum test, as methods for assessment of the maximum strength of the subjects arm flexors. On 14 subjects, non-athletes, at age of 19 +/- 0.5 years, 6 weeks of experimental programme was conducted to stimulate the elbow flexors with maximum muscle load. Exercises (flexion) were performed by lifting external weight with one-arm weight on Scott bench. The isokinetic maximum peak torque and one-repetition maximum were tested in three time sequences (1. beginning, 2. after the 3th week and 3. after the 6th week. Results shows that there is no statistically significant difference in the maximum torque in the subjects tested after first three weeks of exercises (p=0.43, d=0.24±0.40), after the next three weeks, 3rd to 6th week (p=0.68, d=0.27±0.23) as well as in total of 6 weeks of the experimental procedure (p=0.78, d=0.51±0.53). The results for one-repetition maximum test, shows significant positive changes in the values for the arithmetic mean for maximum strength after the 3rd week, by 20.9% [±7.9] for p=0.00 (d=0.45±0.15) between 3rd to 6th week by 19.9% [±5.0] (p=0.00; d=0.43±0.10) and in total following the 6 weeks of training, significant change by 45.0% [±10.6] at level p=0.00 (d=0.88±0.17). Those differences in test probably appear because of the [1] manner in which maximum torque test is performed (biomechanical differences between to tests), [2] simultaneous testing of flexion + extension as a part of biodex testing protocol, as well as the [3] phenomena of "learned movement" during exercises, which is slightly different compared to the movements executed when testing the Biodex devices.

Keyword: *maximum peak torque, 1RM, isokinetic, training, flexors, experimental program, muscle power*

Introduction

Contemporary lifestyle requires efficient time utilization. Practitioners, during recreation and sports, prefer to conduct activities that are efficient for them, and for which least time will be consumed for the realisation of their objective, which is the transformation of specific motor capacity. On the other hand, the research community, in the field of kinesiology, is under increasing pressure to go into details when setting fitness programmes and the control thereof. The objective is to make them functional, so as to present them at the fitness market.

When creating fitness programmes, the initial step is to set an experimental programme the functionality of which is to be proven. In order to present the programme effects, it is necessary to select real measuring mechanisms-tests, which will be used for the purposes of making an actual assessment of the achievements from experimental procedures.

For the experimental procedures in which maximum muscle strength is transformed, the one-repetition maximum 1-RM test is most often used (Milenkovski J., Jovanovski J., Strezovski G.,). However, the need for more precise evaluation of the muscle strength capacity has launched the isokinetic machines on the market, as a laboratory variant for power capacity assessment, with vast (and quality) number of information, collected within a short period, in only few movements in particular joint of the human body (Brown, L. E., 2000).

Isokinetic tests are not entirely new; they have been used long time ago as muscle strength test method. In 1967, Perrine introduced a new speed-controlled device which was described as 'cybernetic exercise'

(Wimpenny P., 2016). In 2017, the technology has developed the current three-dimensional isokinetic machines, which are increasingly becoming part of each sport laboratory.

As an easy and precise method for muscle potential assessment, isokinetic machines are used particularly for medical purposes, as post-operative arthroscopy for muscle strength testing (Ericsson YB, 2006; Koutras G, 2012; Woods GW,2006; Miura K, 2004), as well as for restoring of the muscle function (Fabiś J, 2007; Asagumo H, 2007; Moisala AS 2007). In their meta-analysis Ellenbecker et all (2000), concluded that: "Isokinetic training and testing is an important part of the comprehensive evaluation and rehabilitation of the patient with a shoulder injury. Research has demonstrated its efficacy in training and in providing clinically relevant information regarding muscular performance"

According to different joints of human body, isokinetic find good practice in testing/ rehabilitation in knee Harilainen,2006), shoulder Bellumore Y, Mansat M, Assoun J. (1994), elbow (Peeters T et al., 2009), wrist (Croisier JL et al, 2007), hip (Boling MC, Padua DA, Alexander-Creighton R, 2009) or ankle (Gribble PA, Robinson RH., 2009).

In kinesiology research, isokinetics assumes a high position as a method for assessment of the strength capacities of the subjects, Brown, L. P., et all, 1988, (max. peak torque); Bennell, K., et all, 1998; Ellenbecker, T. S., et all, 2006), and especially the maximum torque test, Perrin, D. H. (1993). This is particularly due to the fact that metric specifics are with high coefficients, which is of particular importance for the scientific research procedures (Bohannon, R. W.,1986; Feiring, D. C., et all, 1990; Sole, G., et all., 2007; Saenz, A., et all. 2010).

The objective of this research was to compare the isokinetic test for maximum peak torque and the one-repetition maximum test, as methods for assessment of the maximum strength potential of the subjects.

Both test (1RM and max. peak torque) are recommended as muscle strength assessment methods (Brown, L., Weir, J.P., 2001). Nevertheless, there are claims that the results obtained by maximal peak torque and 1RM are not equivalent when evaluating individual responsiveness and/or the efficacy of an intervention on muscle strength, as the results obtained show large variations and can be even conflicting, Gentil, P., et all, (2017), but they did not include elbow flexor's in their research.

In this research, the method for comparison of the two tests was through implementation of an isolated experimental procedure, and whether it shall demonstrate that maximum torque and the 1RM test are identical tests which assess the maximum power of the subjects.

Materials & Methods

The research was conducted on 14 subjects, non-athletes, at age of 19 +/- 0.5 years.

The objective of the experimental programme was to stimulate the elbow flexors with maximum muscle load (1 to 3 repetitions). Exercises (flexion) were performed by lifting external weight with one-arm weight on Scott bench (for elbow flexor muscles- m.biceps brachii, m.brachialis, m.brachioradialis). Before launching the experimental programme, subjects were tested for one-repetition maximum (1RMBI) on Scott bench as well as for maximum peak torque (BIPTRQ), on isokinetic machine. All subjects have executed the programme within a six-week period, and have worked with maximum external load, three times a week. Dosage of external load in the experimental programme was the same for all subjects, and was defined from the one-repetition maximum test, amounting 90% of 1RM of the achieved results. The number of repetitions was limited to one, and up to mostly 3 repetitions. The number of sets was limited to 3 sets per training. Break between series was limited to 3-5 minutes. Changes of muscle strength in the subjects (for both groups) was individually monitored, at each training, so as to intervene in the external load, thus maintaining the load level of 90% of 1RM throughout the programme. This means that weight was chosen for each subject, at each training, which limited the number of repetitions in each series from one to three repetitions. In this manner, it was ensured that muscle loads during exercises were maintained within the zone of muscle strength stimulations, with no more than 3 repetitions. Personal records were kept for each subject throughout the experimental procedure (42 days, 18 exercise units) so as to record potential personal changes of muscle strength. Following the three-week treatment (21 days), control test was conducted for 1RM and the maximum torque. Following the realisation of the six-week experimental programme, at the final testing (42nd day), the envisaged tests were implemented, as on the control testing.

The isokinetic maximum peak torque test -BIPTRQ [Nm] was tested on Biodex Multi-Joint System (#900-550), machine. Subjects were tested fixed on the machine in a seating position. The non-dominant arm was supported by the upper arm at height of 45° against the torso. Subjects performed 5 maximum

repetitions (flexion/extension) on the biodex machine, at speed of 60 degrees/second. Results are presented in kilograms [kg];

The one-repetition maximum test (1RMBI) was tested on Scott bench (under angle of 45^0 against the floor vertical), with one-arm weights from 1-20 kg, at elbow flexion, on the non-dominant arm. Subject is in standing position, upper arm on the non-dominant arm, with its rear side (with all its surface) supported by the front bench side. Results are presented in kilograms [kg];

Differences in groups, for applied tests, from initial, to control, and up to the final measuring, were tested with Wilcoxon post hoc test. The Cohen'd effect size with 90 % CL were evaluated as trivial (0–0.19), small (0.20–0.49), medium (0.50–0.79) and large (0.80 and greater) (Cohen, 1992).

Results

Post hoc (Wilcoxon) test, Table No 2, has shown that there is no statistically significant difference in the maximum torque (BIPTRQ) in the subjects tested after three weeks of exercises (p=0.43, d=0.24±0.40), as well as in the next three weeks (3rd to 6th week) of the experimental procedure (p=0.68, d=0.27±0.23). The Wilcoxon test, realised on the data from the initial and final testing (after 6 weeks of the experimental procedure), also showed no statistically significant changes in the values for the maximum torque (p=0.78, d=0.51±0.53).

Table No 1. presents the basic statistical indicators for the tests for one-repetition maximum and the maximum torque.

Table 1. Basic statistics

test	Initial			control			final		
	mean±Sd	Min	Max	mean±Sd	Min	Max	mean±Sd	Min	Max
1RMBI	13.32±1.20	12.00	15.00	16.42±2.19	12.50	20.00	19.41±2.38	15.00	23.50
BIPTRQ	49.25±7.44	36.50	64.80	47.91±6.52	29.60	55.00	48.18±6.11	37.30	57.30

1RMBI-one repetition maximum; BIPTRQ-max pick torque (isokinetics);

Table 2. In the groups differences, change in mean % and effect size at initial, control, and final tests, for flexor muscles (BIPTRQ-test).

Test: BIPTRQ	Wilcoxon p-level	Change in mean %	Chances for value: smaller/similar/greater	Uncertainty in the true differences	Cohen's d ± 90% CL
initial/control	0.43	6.6 ±11.4	59/37/4	possibly +ive	0.24 ± 0.40
control /final	0.68	7.4 ± 6.4	73/27/0	possibly +ive	0.27 ± 0.23
initial/final	0.78	14.5 ±16.3	85/13/2	likely +ive	0.51 ± 0.53

initial/control - first 3 weeks; control /final-second 3 week (3th to 6th week); initial/final- total 6 weeks of experimental program

Unlike the statistical analysis of the BIPTRQ test, for the one-repetition maximum test (1RMBI), the test results have shown significant positive changes in the values for the arithmetic mean for maximum strength after the 3rd week, by 20.9% [±7.9] for p=0.00 (d=0.45±0.15). In the second part of the programme (3rd to 6th week), the maximum strength of the subjects was statistically significantly improved by 19.9% [±5.0] (p=0.00; d=0.43±0.10). When testing the changes of the total effect following the 6 weeks of training, significant change is observed by 45.0% [±10.6] at level p=0.00 (d=0.88±0.17) between the initial and final test. This interpretation is supplemented by the information from Table No 1 on the mean value for the minimal [min] and maximal [max] result of the lifted weight in the three tests.

Table 3. In the groups differences, change in mean % and effect size at initial, control, and final tests, for extensor muscles (1RMBI-test).

Test:1RMBI	Wilcoxon p-level	Change in mean %	Chances for value: smaller/similar/greater	Uncertainty in the true differences	Cohen's d ± 90% CL
initial/control	**0.00**	20.9 ±7.9	99/1/0	very likely +ive	0.45 ± 0.15
control /final	**0.00**	19.9 ±5.0	100/0/0	most likely +ive	0.43 ± 0.10
initial/final	**0.00**	45.0 ±10.6	100/0/0	most likely +ive	0.88 ± 0.17

initial/control - first 3 weeks; control /final-second 3 week (3th to 6th week); initial/final- total 6 weeks of experimental program

Discussion

The objective of the research was to answer whether the isokinetic tested maximum torque is a good example for the progress of maximum strength in subjects following the six-weeks training, of the elbow flexors, with free weight training.

A unique finding in this research is that maximum torque does not really present the progress of maximum strength in elbow flexor muscles (non-dominant arm), following the 6-week training with free weights. Unlike the maximum torque, the one-repetition maximum test, executed with free weights, has displayed significant changes in the three testing points. The conclusions of this research are similar to the conclusions of Gentil, P., et all, 2017, de Souza et al., 2010; Feiereisen et al.,2010; Gentil et al., 2010.

Similar method, yet reverse training manner (in reference with this research), was performed by Ratamess, et all. (2016). They performed 6-week training on isokinetic machine, and muscle strength assessment with free weight test. Authors have presented that the free weight test presents the existence of positive changes following the training on isokinetic machine.

Conclusion

Having in mind the research results, perhaps the answer should be sought in:

1. The manner in which maximum torque test is performed.

Although, to a significant extent, movements on the Biodex machine that were performed so as to test the flexor muscles, simulate movements which were also executed during training, the results have, however, shown that most probably these are not identical movements (Biodex vs 1RM). In biomechanics terms, training with free weights required involvement of muscles that help the movement, such as muscle fixators and similar (Vuksanovic, V., Handjiski, Z., & Handjiska, E. (2014). In addition, the 1RM test procedure is identical method with the training. However, with the biodex testing, although generally, the same large musculature in the elbow joint is included, it still does not refer to lifting of free weights, but opposition to force generated by the branch of the machine whose lever has precisely defined trajectory of movement. Similar interpretations can be found at Gentil, P., et all, 2017; Chmelo et al., 2015; Churchward-Venne et al., 2015; Gentil et al., 2015a.

2. This procedure uses the method for simultaneous testing of flexion + extension, which could potentially have an impact on the maximum torque results. In general terms, biodex procedures are executed in this manner so as to perceive whether there is an imbalance between the two opposite muscle groups in the elbow joint (agonists/antagonists).

3. Potentially, the increase in lifted weight (tested through one-repetition maximum) is based on "learned movement" during exercises, which is slightly different compared to the movements executed when testing the Biodex devices.

Recommendation for future research: perhaps it is necessary to also choose another type of angle speed in case of isokinetic testing. This research used angle speed of 60 degrees/second.

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