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Original Article

Peak torque substantially varies between patients with non-specific low back pain; belong to directional preference classification, and healthy individuals—clinical biokinesiologic perspectives

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Abstract. [Purpose] To compare flexion and extension peak torque of patients with nonspecific-chronic low back pain who were classified as directional preference subgroups, and their matched healthy controls. [Participants and Methods] Fifty male volunteers (25 with non-specific chronic low back pain and 25 healthy-matched controls) consented to participate. The investigator collected all demographic data, hips, knees and spinal mobility in addition to the peak torque using the Biodex isokinetic dynamometer. The measurement protocol consisted of 2 sets of 10 consecutive flexion-extension efforts performed at 120°/sec and 60°/sec angular velocity. A two minutes rest period was given between sets. The preset 50° range of motion included 20°(+20°) of trunk extension and 30°(−30°) of trunk flexion. [Results] A 2 × 2 mixed-design ANOVA showed a significant group X isokinetic velocity interaction. The main effect of isokinetic velocity was also significant. In reference to the peak torque of the flexors of the trunk, the main effect of group was significant. [Conclusion] The extension peak torque significantly depends on the velocity of the isokinetic dynamometer; however the flexion peak torque significantly depends on the participants' group attribution.

Key words: Clinical biokinesiology, Directional preference, Isokinetic peak torque

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INTRODUCTION

Low back pain is a very common physical health problem that results in high incidence of disability among working adults[1)]. It has been reported that the prevalence of at least one episode of LBP affects more than 80% of population during their lives[2)]. The prevalence of chronic low back pain has substantially risen which imposing huge burden on the health care system[3)]. Chronic non-specific low back pain has been extensively studied and reported in literature[4–6)]. Weakness and decreased endurance of the trunk muscles were a major challenge that jeopardizes the stability and biomechanical integrity

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of the axial musculoskeletal apparatus[7–9]. Trunk flexors and extensors strength is fundamental for enjoying satisfactory high quality spinal stability and mobility of the axial skeleton[10]. Isokinetic testing has been extensively reported in literature to study trunk muscles strength[11, 12]. Peak torque of trunk muscles is one of the best outcome measurements among healthy individuals as well as patients who have low back pain. Peak torque of flexion/ extension; recorded at sagittal plane of trunk movement, has been sufficiently validated in literature[13–16]. However, the directional preference and its differential effect on the peak torque have not been addressed among patients with low back pain. The uncertainty in literature among researchers has justified the need to determine the difference in peak torque, if any, between patients who suffer from chronic low back pain and their matched healthy group with respect to the directional preference of movement. The investigators hypothesize that the peak torque of flexion and extension of the trunk would not differ between low back pain patients and their matched control. The main objective of the current study was to compare the flexion and extension peak torque obtained from patients with low back pain and their matched group with respect to directional preference.

PARTICIPANTS AND METHODS

Fifty male volunteers (age: 23.5 ± 3.8 years; height: 169.5 ± 7.8; weight: 76.5 ± 20.4; BMI: 26.5 ± 6.6) participated in the study. Twenty five participants had been diagnosed with non-specific chronic low back pain (NS-CLBP). Another twenty five healthy individuals were matched to participate. A sample of convenience was used for sampling of participants. A data collection form was obtained from every volunteer before participation. Regarding healthy individuals, they were included if they are healthy, between the age of 20 and 40 years and engaging in regular physical activity. They were excluded if they suffer from recent back injury, abdominal surgery or any physical disorder. In reference to patients with low back pain, they should have been diagnosed by medical doctor to have NS-CLBP which is chronic for over than three months. Patients were excluded if they suffer from significant limitations particularly with their sagittal flexion-extension trunk mobility. All participants were informed in details about the study before signing the consent to participate. The study protocol was approved (CMRS-PT- 2019-04) by research ethics committee at college of medical rehabilitation sciences. First, the investigator collected all demographic data followed by measuring hips mobility, knees mobility and all spinal mobility especially flexion-extension mobility. Every participant was evaluated during functional testing of lumbo-sacral motor control from standing and sitting positions. Every participant has to assume multiple positions including usual and slumped sitting positions, standing position, forward bending and return to neutral in addition to backward bending. The investigator visually observed the kinematics of lumbo-sacral region and muscle activation pattern. The investigator asked every participant about the musculoskeletal pain experienced to classify him to certain subgroup[5, 17–19]. Before actual testing, participants executed a warm-up session to familiarize first ahead of the actual measurements. Sub-maximum effort of trunk flexion-extension was carried out using one set of 10 repetitions.

The isokinetic measurements were performed on a Biodex isokinetic dynamometer (Model System 3 pro; Biodex Medical Systems Inc., 20 Ramsay Road, Shirley, NY, USA). The set up started by having every participant placed on the dual-position of back extension-flexion attachment while having the trunk in the upright position and the dynamometer axis of rotation aligned with an imaginary line that extends between anterior superior iliac spines. Hips and knees were maintained at 90°, thighs parallel to the floor and trunk excursion was limited at 50° relative to the (0°) anatomical reference position. The preset 50° range of motion included 20°(+20°) of trunk extension and 30°(−30°) of trunk flexion. All measurements were executed by experienced investigator at the same time of the day to ensure excellent intrarater reliability. The 50° of excursion would better isolate lumbar motion while reducing hip flexion-extension interference. To ensure stability during measurements Velcro straps were placed on upper trunk, the pelvis and the thighs in addition to having adjustable pads behind the head, the sacrum, the upper trunk and the anterior surface of the tibia. Participants were instructed to keep their arms and hands crossed over their chest during measurements. The measurement protocol was strongly adopted by researchers in recent study[11].

The measurement protocol consisted of 2 sets of 10 consecutive flexion-extension efforts performed at 120°/sec and 60°/sec angular velocity. A two minutes rest period was given between sets. The investigator was verbally encouraging every participant to exert the maximum effort throughout measurements from the beginning to the end of the test. Regarding the statistical analyses, a number of descriptive and inferential statistics were conducted on the study variables. Homogeneity of variances of pairwise differences; between different levels of isokinetic velocity within healthy and patients with low back pain, was evaluated using Mauchly's test of sphericity. Kolmogorov-Smirnov test was used to establish the normality of data distribution. A 2 group (healthy vs. patients) ×2 speed (60°/sec and 120°/sec) mixed design ANOVA was run to check any significance within and between groups. IBM SPSS 24.0 was the software used for data analyses. (IBM Corp., Armonk, NY, USA).

RESULTS

Mauchly's test of sphericity indicated that the assumption of sphericity is satisfied since the p value was >0.5. The normal distribution of the data was established ($p>0.05$). A 2 × 2 mixed- design ANOVA was calculated to examine the effects of two different isokinetic velocities (60°/sec and 120°/sec) and group (back pain patients and healthy-matched subjects) on peak torque of both flexors and extensors of the trunk.

Table 1. Peak torque of trunk extensors and flexors at 60°/sec and 120°/sec within low back pain patients and healthy-matched individuals

	Patients group		p value	Healthy group		p value
	60°/sec	120°/sec		60°/sec	120°/sec	
Extension peak torque	93.05 ± 61.7	71.50 ± 54.4	<0.05	134.43 ± 86.2	85.06 ± 57.3	<0.05
Flexion peak torque	90.65 ± 34.2	82.69 ± 34.4	>0.05	117.72 ± 39.1	114.92 ± 44.8	>0.05

Mean ± SD.

Table 2. Peak torque of trunk extensors and flexors at 60°/sec and 120°/sec between low back pain patients and healthy-matched individuals

	Extension peak torque		p value	Flexion peak torque		p value
	60°/sec	120°/sec		60°/sec	120°/sec	
Low back pain patients	93.05 ± 61.7	71.50 ± 54.4	>0.05	90.65 ± 34.2	82. 69 ± 34.4	<0.05
Healthy matched individuals	134.43 ± 86.2	85.06 ± 57.3		117.72 ± 39.1	114.92 ± 44.8	

Mean ± SD.

Regarding the peak torque of the extensors of the trunk, a significant group X isokinetic velocity interaction was present ($F_{(1,48)}$=4.38, p<0.05). The main effect of isokinetic velocity was also significant ($F_{(1,48)}$=28.47, p<0.01) with higher peak torque at 60°/sec than at 120°/sec for patients as well as for healthy subjects. The main effect of group was insignificant ($F_{(1,48)}$=2.47, p>0.05) (Table 1).

In reference to the peak torque of the flexors of the trunk, insignificant group X isokinetic velocity interaction was present ($F_{(1,48)}$=0.30, p>0.05). The main effect of isokinetic velocity was also insignificant ($F_{(1,48)}$=1.30, p>0.01). The main effect of group was significant ($F_{(1,48)}$=9.20, p<0.005) with higher peak torque obtained from healthy subjects compared with the non-specific low back pain patients group (Table 2).

DISCUSSION

The main findings of the current study were the significant difference in extension peak torque of the trunk muscles when tested at different velocities (60°/sec and 120°/sec) in patients with low back pain as well as healthy matched individuals. In contrast, insignificant difference was found for the flexion peak torque. In reference to between groups, a significant difference was recorded for the peak torque at flexion direction but insignificant difference was recorded at extension direction. Although peak torque was always reported in the majority of isokinetic studies in clinical and research fields; to the best of our knowledge and after searching, it was inadequately studied among the subgroup of patients who have low back pain and classified as subgroups of directional pattern of preference. Although Dankaerts et al.[5] and Dankaerts et al.[19] have described five different directional patterns of motor control, researchers in the current study have included only patients with flexion pattern and active extension pattern. Therefore, the interpretation of the variation in peak torque will be explained just specific to active flexion and active extension pattern. Dankaerts et al.[5] and Dankaerts et al.[20] emphasized on the role of motor control as underlying mechanism for causing pain. The lack of adequate motor control could impose ongoing strain on the spine and its sensitive structures which results in the chronic but non-specific pain.

Motor control impairments might have altered muscle activation pattern with subsequent variation in peak torque between groups. The results coincide with the findings found by Dankaerts et al.[20] who studied trunk muscles activation in a group of patients with non-specific low back pain and reported a significant alteration in the pattern of activation of superficial muscles of the trunk. Therefore researchers are in agreement with the need to modify exercises based on the level of muscle activation[21]. Olson[22] studied abdominal and lumbar paraspinal trunk muscle during sub-maximal extension effort against an isokinetic dynamometer. Paraspinal muscles showed signs of fatigue with subsequent changes in the muscle activation levels to be in harmony with the force output required. The level of muscle activation is determined through different motor control strategy under the control of neuromuscular system. The neuromuscular system gauges the level of muscle activation required according to the load experienced during the isokinetic resistance. The load varies according to the velocity used during isokinetic testing. Ripamonti et al.[23] demonstrated the importance of torque-velocity relationship during any rehabilitation program. Researchers had their measurements on a group of low back pain patients. They corroborate the role of strengthening the trunk extensors to have successful outcomes with low back pain patients. On the other hand, the significant difference that was found within groups regarding the peak torque at different velocities could be attributed to the load experienced and the required muscle activity especially when doing the active extension. The findings correspond with the findings reported by Callaghan et al.[24] who studied the relationship between lumbar spine load and muscle activity during active extension exercises. The results of the study showed trunk extension exercises had the highest muscle activity levels and compressive loading on the spine measured at L4–L5 level. Callaghan et al.[24] had a sample of 13 university students' volunteers with a mean age of 21 but were free from any pain at the lower back. We hypothesize that presence of pain at the lower back could have prompted participants to do muscle guarding which might have increased muscle activity and imposed more compressive loading on the sensitive structure. Moreover, Dankaerts et al.[5] studied 33 patients with NS-CLBP and 34 healthy controls through collecting kinematic and kinetic data to quantify parameters of motor control. Researchers have used multiple postures and movements including forward bending and return, standing, backward bending and return. Researchers have used parameters of motor control to develop statistical classification model. The model was successful in classifying 96.4% of cases. O'Sullivan[25] pointed out the importance to link the motor control impairment to the clinical data and the maladaptive movement behaviour in order to better understand the underlying mechanism of pain.

Furthermore, the heterogeneity of motor control among patients diagnosed with NS-CLBP dictates that all clinicians should first classify every patient before any clinical research or therapeutic management. El-gohary and Abdelkader[12] emphasized on having clinicians to consider the level of difficulties experienced by participants during exercises in order to design a viable gradual resistive exercise program.

There are several limitations within this study such as having only a sample of male participants since it was difficult to recruit female participants during the time of the study. It was beyond the scope of this study to compare the active flexion with the active extension patients group since the study mainly purported to compare NS-CLBP patients with healthy individuals. Therefore, researchers have pooled all patients with low back pain. Moreover, there was a wide period of time to label patients as chronic which ranged from three month to several years. There was also wide range of body mass index (16 to 47) which reflects participants from underweight to obese classification.

It can be concluded, based on this study findings, that the extension peak torque significantly depends on the velocity of the isokinetic dynamometer; however the flexion peak torque significantly depends on the participants group attribution. Further studies are needed to explore the difference between different directional preference subgroups among patients with NS-CLBP.

Conflict of interest

No conflict of interest to report.

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