Lumbar Repositioning Accuracy in Low Back Dysfunction

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ABSTRACT

Purposes: *To compare the difference in repositioning accuracy between low back dysfunction and healthy subjects, and to investigate the difference in the degree of repositioning accuracy in relation to the cause of low back dysfunction.* ***Study Design:*** *A control group one-shot study.* ***Subjects and methods:*** *Forty-five subjects from both sexes were involved, aged between 30 – 50 years. They were divided into three equal groups. Subjects in the first group were normal healthy subjects. Subjects in the second group had a history of non-specific mechanical low back dysfunction, while subjects in the third group had discogenic low back dysfunction. Biodex system isokinetic dynamometer, equipped with a special forward reclined seat, was used to measure the lumbar repositioning accuracy. Subjects were required to reproduce a target position (30º flexion). The mean deviation about the 30° target position was calculated for each subject.* ***Results:*** *The study revealed that there were significant differences ($p< 0.05$) in the repositioning accuracy among the three groups. The Absolute errors were greater in the two low back dysfunction groups than in the control group. On the other hand, there were no significant differences ($p> 0.05$) in the repositioning accuracy between the two low back dysfunction groups.* ***Discussion:*** *The healthy subjects repositioned their back more accurately to the target position. While, the low back dysfunction groups had a significantly larger absolute error. Conclusion: Differences in proprioception do exist between subjects with back dysfunction and normal subjects. The proprioceptive deficits do exist regardless to the cause of the back dysfunction.*
Key words: *Low back dysfunction, position sense, proprioception.*

INTRODUCTION

Low back dysfunction (LBD) is one of the most common medical problems of the middle-aged population and it is the most costly musculoskeletal disease in industrialized countries[1]. Epidemiological studies have shown that about 60% to 80% of the population will experience LBD at some stage in life[2]. Most people will have at least one backache during their lives, and many will live with recurrent orprolonged back problems[3].

LBD is classified according to the anatomic structures affected along with the clinical symptoms. The most common origin of LBD is from the musculo-ligamentous structures. However, discogenic abnormalities can also be pain generator[4]. Non- specific mechanical LBD, which is due to chronic strain on the muscles of the lower back, may be caused by obesity, pregnancy, job-related stooping, bending, or other stressful and bad postures. It usually does not cause weakness or numbness in the leg or foot, because the problem is not from pressure on the spinal nerves[5,6]. However, discogenic LBD is the pain felt in the lumbar region with numbness or pain in leg or foot. It occurs when spinal nerves are inflamed or squeezed due to disc herniation[5,7].

Over the past decades, researchers and clinicians have failed to identify the mechanisms responsible for chronic back conditions. The presence of sensory – motor deficits in low back population is one of the current hypotheses that could explain the high prevalence of low back conditions. Many

authors have demonstrated that sensory – motor deficits are present in LBD patients. These deficits can affect and compromise segmental spinal stability and eventually lead to articular damage and subsequent chronic pain[8,9].

Impaired motor and sensory functions associated with LBD may include disturbance of sensorimotor control mechanisms and impaired postural responses. However, characteristics, physiological mechanisms, and clinical relevance of these findings in different spinal pathologies require further clarification[10]. Impaired joint position sense is overlooked in many rehabilitation programs, and may be a major risk factor for recurrent injuries after the integrity of the muscles and ligaments has been restored[11].

Although many current back rehabilitation programs are designed to improve proprioception under the assumption that proprioception is lost in subjects with LBD, and that proprioception is a crucial element in rehabilitation of patients with low back dysfunction, However, very little research exists to support this[12,13]. Proprioception, muscle control and coordination training could be the key issues in resolving neuromuscular dysfunction in patients with LBD, but there is no standard ways reported to assess these parameters[14].

The purposes of the study were to determine whether repositioning accuracy as a measure of proprioception differs in subjects with and without LBD, and to investigate the difference in the degree of repositioning accuracy in relation to the cause of LBD whether non- specific mechanical or discogenic.

SUBJECTS AND METHODS

1) Design of the study

A control group one-shot study was used to compare the difference in the lumbar repositioning accuracy between two different low back dysfunction populations compared to control subjects. Lumbar repositioning accuracy was measured three times for each subject.

2) Characteristics of subjects

Forty-five subjects, recruited from the Faculty of Physical Therapy outpatient clinic, participated in the study. They were assigned into three equal groups. Each group consisted of 15 subjects. Subjects in group I were normal subjects who had experienced no past episode of low back pain. Subjects in group II had a history of non-specific mechanical chronic low back dysfunction. Subjects in group III had a diagnosis of chronic low back dysfunction due to a disc herniation.

3) Instrumentation

Biodex system 3 pro isokinetic dynamometer (Biodex Medical INC., Shirley, New York, USA), equipped with a special forward reclined back attachment, was used to measure the repositioning accuracy of the lumbar region in this study.

4) Procedure

a) Initial preparation

All subjects agreed to participate in the study by completing an informed consent form. The experimental groups were asked to report their pain level by using a Visual Analogue Scale (VAS). An Oswestry Disability Index was administered for each subject in the experimental groups for assessment of the functional level and the induced disability in the daily functions and

leisure-time activities. The ages of subjects were recorded and their heights and weights were measured. Subjects were given verbal instructions concerning the purpose and procedure of the study.

b) Measurement of repositioning accuracy

The Biodex system 3 pro was started, then system calibration and stabilization were done prior to each testing session. The subject was stabilized on the chair of the Biodex system. Each subject was positioned into an upright neutral starting position. The predetermined spinal range of motion, which was chosen to be the "target position" for the subjects during the testing protocol, was from neutral spinal posture to 30° lumbar flexion.

Once each subject had completed the practice trial, the standard test session started which consisted of the following: each subject was positioned in 30° of lumbar flexion for 10 seconds and he was instructed to remember the position because he will be asked to reproduce this position. Then the participant returned to the neutral position and then was given the verbal instruction of reproducing the target position as accurately as he can. No verbal or visual feedback on accuracy was provided to the subjects. The absolute error (AE) values about the 30° target position was recorded for each subject.

5) Data collection and statistical analysis

The repositioning error was measured for each subject over three trials. The mean deviation or absolute error (AE) about the 30° target position was calculated for each subject. Descriptive statistics (mean and standard deviation) was used. One way analysis of variance (ANOVA) was used to determine significant differences in the repositioning error between the groups across the period of measurement. LSD post hoc test was performed to distinguish groups that differ from each other. The level of significance for all tests was set at ($P \leq 0.05$).

RESULTS

Subjects characteristics

Forty five subjects participated in the study (32 males and 13 females). Their ages ranged from 30 to 50 years with mean age (39.4 ±5.5) years, their weights ranged from 55 to 100 kg with mean weight (83.3 ±12.2) kg, and their heights ranged from 148 to 185 cm with mean height (171.8 ±9.2) cm. The subjects were assigned to three equal groups. Each group consisted of 15 subjects. Characteristics of subjects in each group are shown in table (1) and figure (1).

Table (1): Characteristics of subjects in each group.

	Groups						P	Sig.
	Control		Mechanical		Discogenic			
	Mean	S.D	Mean	S.D	Mean	S.D		
Age (yrs)	38.5	±5.85	40.1	±6.1	39.7	±4.5	0.693	NS
Weight (Kg)	83	±13.4	85.5	±10.6	81.3	±13	0.649	NS
Height (cm)	174.3	±6.25	169.9	±10.4	171.3	±10.4	0.432	NS
VAS (mm)	----	----	63	±8.2	65	±9.4	0.539	NS
ODI (%)	----	----	28.2	±6.5	33.5	±7.7	0.051	NS

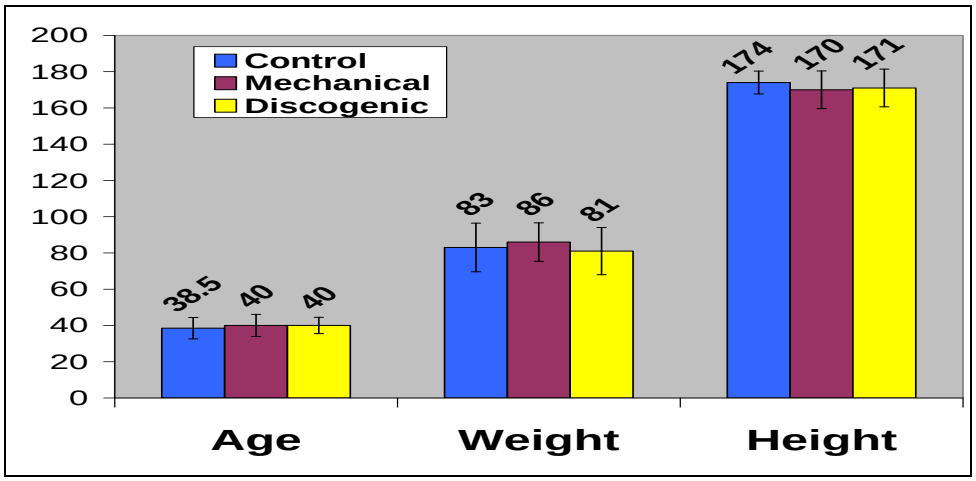

Fig. (1): Showing the characteristics of subjects in each group.

Repositioning accuracy

The Absolute Errors (AE), measured in degrees, between the target and the reproduced position in the three testing trials were calculated for all subjects in the 3 groups, and then the average repositioning Absolute Error for each subject was calculated, as shown in table (2), figures (2), and (3).

Table (2): The average AE (in degrees) between the target and the reproduced position for the three groups.

Group	N	Mean	SD	Minimum	Maximum
Control	15	2.8467	.9433	1.00	4.30
Mechanical	15	7.5000	3.2693	2.30	14.00
Discogenic	15	7.1933	2.3273	2.70	11.30

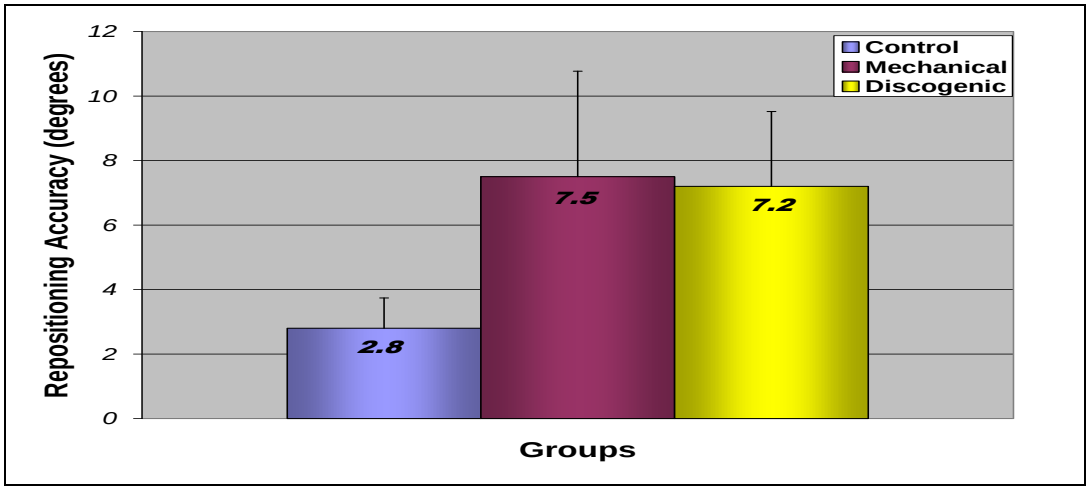

Fig. (2): The average AE (in degrees) between the target and the reproduced position for the three groups.

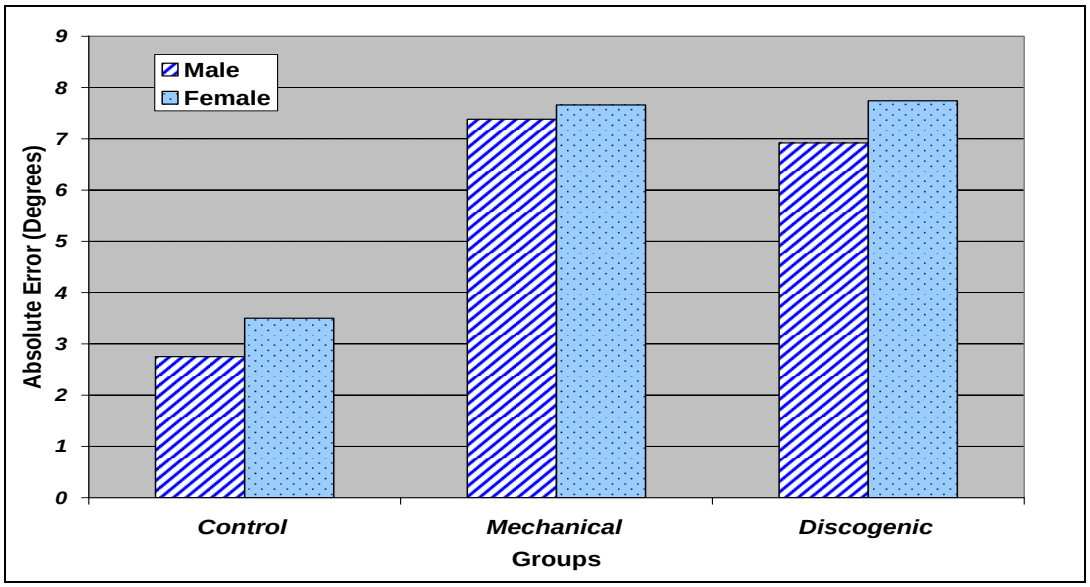

Fig. (3): The average absolute errors (in degrees) between the target and the reproduced position for the male and female subjects in the three groups.

Differences in repositioning accuracy among the three groups

To determine the differences in the mean values of the AE among the three groups, analysis of variance (ANOVA) was performed. It revealed that there were significant differences among the mean values of the three groups ($P<0.05$). Lumbar repositioning AE values were significantly greater in the two LBD groups than in the control group. The healthy subjects repositioned the back more accurately to the target position, as shown by their average AE, while, the low back dysfunction groups had a significantly larger AE. The F value between groups was 17.935, while the P value was < 0.0002, which indicated significant difference between the three groups. Application of LSD post hoc test revealed significant differences in the repositioning AE between the control and the non-specific mechanical low back dysfunction groups where the mean difference was -4.65 degrees, while P was 0.0003. As shown in table (3), there were significant differences in the repositioning AE between the control and the discogenic low back dysfunction groups where the mean difference was -4.34 degrees while P was 0.0001. On the other hand, there were no significant differences in the repositioning AE between the non-specific mechanical and the discogenic low back dysfunction groups where the mean difference was 0.31 degrees while P was 0.73.

Table (3): Results of LSD post hoc test among the three groups.

A	B	Mean Difference (A-B)	P	Sig.
Control	Mechanical	-4.6533	.0003	S
Control	Discogenic	-4.3467	.0001	S
Discogenic	Mechanical	-.3067	.726	NS

DISCUSSION

Within the limitations of this study, there were significant differences in the lumbar repositioning accuracy between the control and the two low back dysfunction groups ($P < 0.0002$). Lumbar repositioning Absolute Errors were significantly greater in the low back dysfunction groups compared to the control group as shown by their average Absolute Errors. The healthy subjects repositioned their back more accurately to the target position, While, the low back dysfunction groups had a significantly larger Absolute Errors.

However, by comparing the average repositioning Absolute Errors of the two low back dysfunction groups, no statistical significant differences were found between the non-specific mechanical and the discogenic low back dysfunction groups ($P < 0.73$) showing that the proprioceptive deficits occur with the same degree regardless to the cause of the low back dysfunction whether mechanical or discogenic.

The significant differences in the lumbar repositioning accuracy between the control and the two LBD groups can be attributed to the fact that deep somatic spinal pain may result in alterations of coordination during dynamic tasks, with a change in the normal agonist-antagonist muscle activity relation. Similarly, there is evidence that changes in neuromuscular control and motor performance may result directly from a reaction to the presence of pain [(15)]. However, during the current testing procedure, no subject reported severe pain in the back at the time of testing that may interfere with the measurement, indicating that the potential for direct influence of pain on the study results should be negligible.

The differences in the lumbar repositioning accuracy between the control and the mechanical LBD groups can be explained according to the essential basis of proprioception. The mechanoreceptors operate so that increased stretch or tension produces an increase in afferent signals, while impulses decline with shortening or slack. Thus, mechanoreceptive dysfunction should influence signal output during both increased and decreased stretch and diminish their ability to produce both the increase and decrease in afferent signals during the respective tension changes[16].

Recent research involving the spinal muscles has identified two further explanations that may account for the findings of the current study. It is possible that pain inhibition of local muscles such as lumbar multifidus may result in deficiencies of motor control and alterations in the normal muscle recruitment pattern resulting in the repositioning deficits. Also, trunk muscle dysfunction may cause alterations in the normal afferent input from the affected muscle. Muscle afferents could be considered primary contributors to position sense[15].

Impaired postural control and lumbar movement perception observed in patients with disc herniation-related back pain and sciatica may be caused by a feedback error resulting from sensory loss, a deficit in information processing, or a combination of both mechanisms. This may explain the differences in lumbar repositioning accuracy between the control and the discogenic LBD groups[17]. Further explanation may be based on the role of the neural control system in maintaining the spinal stability. CNS does not simply stiffen the spine and restrict the spinal motion, but actively uses movements to maintain equilibrium in the posture. Any impairment or dysfunction of the neural control subsystem may lead to proprioceptive deficits and impaired motor control[10].

The non-significant differences found between the two LBD groups showed that the proprioceptive deficits occur with the same degree regardless to the cause of the LBD whether mechanical or discogenic. This impaired position sense in both LBD groups can possibly be attributed to the fact that receptors important for proprioception are affected with dysfunction in the lumbar spine, and these proprioceptive deficits are not compensated, to any appreciable extent, by proprioceptive mechanisms outside the lumbar spine. Individuals with LBD may use other mechanisms, such as the vestibular apparatus, cutaneous receptors on the soles of the feet as well as hip proprioceptors to compensate for the impaired lumbar proprioception[18].

Conclusions

Differences in proprioception do exist between individuals with low back dysfunction and healthy subjects free from back dysfunction. Patients with low back dysfunction have a less refined position sense than healthy individuals. Furthermore, lumbar repositioning accuracy is affected in patients with low back dysfunction to the same extent regardless to the cause, whether mechanical (myogenic) or discogenic low back dysfunction.

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الملخص العربى

دقة إعادة وضع المنطقة القطنية فى الخلل الوظيفى للظهر

يهدف هذا البحث إلى دراسة دقة إعادة وضع المنطقة القطنية فى الخلل الوظيفى للظهرمن خلال مقارنة دقة إعادة الوضع بين مرضي الخلل الوظيفى للظهر و الأصحاء، بالأضافة إلى دراسة مدي الأختلاف في دقة إعادة الوضع تبعاً لسبب الخلل الوظيفى للظهر. تم استخدام جهاز بيودكس3 برو لقياس مدي دقة إعادة وضع المنطقة القطنية، بالأضافة إلى ميزان لقياس الوزن والطول. و تم استخدام المقياس البصري لقياس شدة الألم و مؤشر عجز أوسوسترى لقياس درجة العجز نتيجة الخلل الوظيفى للظهر. و قد أجريت هذة الدراسة بكلية العلاج الطبيعى خلال المدة من أكتوبر إلى يناير 2006 م . تم أجراء هذا البحث على خمسة و اربعين فرداً من مرضي الخلل الوظيفى للظهر و الأصحاء من كلاُ الجنسين (13 إناث ،32 ذكور) ، تراوحت أعمارهم من 30 إلى 50 سنة بمتوسط (5.5±39.4) سنة، ومتوسط أوزانهم (12.2±83.3) كجم، ومتوسط أطوالهم (9.2±171.8)سم. و قد تم تقسيمهم إلى ثلاث مجموعات متساوية: مجموعة الأصحاء (15 فرداً) ، مجموعة مرضي الخلل الوظيفى للظهرالناتج عن سبب ميكانيكى (15 فرداً) و مجموعة مرضي الخلل الوظيفى للظهر الناتج عن أضطرابات الغضروف (15 فرداً). تم جمع البيانات الخاصة بكل شخص من السن والطول والوزن، ثم بدأ كل فرد بالتسخين لمدة 5 دقائق، ثم تم إجراء الجزء الأساسي من التجربة حيث تم قياس مدي دقة و قدرة كل فرد علي إعادة وضع المنطقة القطنية إلي زاوية محددة مسبقا. وتم حساب مقدارالخطأ لكل فرد . كانت أهم النتائج التي تم استخلاصها وجود أختلافات ذات دلالة إحصائية بين مرضي الخلل الوظيفى للظهرو الأصحاء حيث وجد أن مرضي الخلل الوظيفى للظهر أقل قدرة علي إعادة وضع المنطقة القطنية إلي زاوية محددة مسبقاُ بصورة دقيقة، حيث كان مقدارالخطأ في مجموعتي الخلل الوظيفى للظهر(7.5 و 7.2 درجةعلى التوالى) بينما كان مقدارالخطأ في مجموعة الأصحاء (2.8 درجة). كما تبين انه لا يوجد أختلاف في دقة إعادة وضع المنطقة القطنية بأختلاف سبب الخلل الوظيفى للظهر، حيث تبين انه لا يوجد أختلافات ذات دلالة إحصائية بين مجموعتي الخلل الوظيفى للظهر.