Triaxial Torques of Trunk Muscles in Individuals with Mechanical Low Back Pain

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ABSTRACT

This study was conducted to investigate and analyze the effect of a specific isokinetic training program on the torque exerted by the trunk muscles of subjects working for prolonged times while sitting or standing and suffering from back pain of non-pathological origin. Fourty young male subjects suffering from mechanical low back pain aged between 20 and 27 years were investigated. Two groups, namely standing and sitting, were considered. Each subject was evaluated using Isokinetic triaxial dynamometer to determine maximum isometric torque (MIT). The choice of dynamic resistance of the training program was based on isometric test results performed at both 25% and 50% of MIT. Each subject received the same isokinetic training program three times per week for four consecutive weeks. The following variables were measured 1) torque of the trunk muscles, 2) the maximum angular velocity, 3) the range of motion "ROM" and 4) subjective pain. Analysis of the results revealed tat subjects in both groups exhibited a significant improvement in all the measured variables at the end of the treatment program. However, the standing group exhibited a better response, demonstrated by a greater increase in both the MIT and dynamic torques. It has also appeared that there was an inverse relationship between the trunk ROM and torque. Meanwhile, pain sensation at the lumbar region was greatly reduced in both groups, wit more relief in the sitting than the standing group.

INTRODUCTION

There is a growing consensus, nowadays, that low back pain (LBP) problems are widely spread over a significant proportion of adults in urban societies. Several epidemiologic surveys conducted in different countries showed that between 35% and 90% of the adult population reports at least one episode of LBP during their life[7,19]. Few studies have investigated the possible effects of different working conditions on the strength of the trunk muscles[8].

On the other hand, there are definitive reports attributing LBP to reduced muscle performance[8]. This, in turn, is a result of the lack of repetitive and regular stimulation to the muscle groups concerned. Sitting for prolonged times, as is the case in most offices, leads to the leaning forwards of both the head and the trunk. Consequently, one is subjected to excessive stress and fatigue occurs[1,8].

Neck and back complaints also arise from prolonged standing. In this case, it is not the magnitude of force per second that causes fatigue as much as the length of time that the force is being applied. Tissue breakdown may occur with overuse or prolonged excessive overloading. This is a result of the accumulation of microstresses over a period of time[15,16].

The isokinetic parameters of the trunk muscles can be investigated using dynamometry. Dynamometry is concerned with the provision of a controlled accommodating resistance and the measurement of the moment exerted by the muscle against this resistance[9]. Because of the variable resistive load produced in a dynamometer, muscle strengthening can be achieved by isokinetic training using dynamometry.

Similar to aerobic exercise, muscle strengthening due to dynamometry can be attributed to 1) the increase in the number of active motor units and their rate of firing at spinal and supraspinal levels, 2) synchronization between motor units, 3) recruitment of additional motor units and 4) increased rate of discharge of motor units[4,28]. In addition, training causes an increase in the physiological cross section of the muscle, Moreover, there is a great increase in the area of fast twitch (type II) muscle fibers compared with slow twitch (type I) muscle fiber[4,14].

While there are several investigations on the effect of training on the torques produced by the trunk muscles[5,27], there seems to be little or no information on the efficacy of such training programs in alleviating mechanical LBP in subjects whose work requires long hours of sitting or standing every day. In addition, this paper investigates the progression of recovery in the two groups and proposes an optimal or near-optimal strategy for their training program. This is achieved by measuring and analyzing 3-D data related to the Range Of Motion (ROM), Maximum Isometric Torques (MIT), Dynamic Average Torque (DAT) and Maximum Average Velocity (MAV). Pain was also evaluated by means of the Visual Analogue Scale (VAS) developed by Scudds (1983)[26].

METHODS

Sample Selection

Forty young male subjects aged between 20 and 27 years and suffering from mechanical low back pain (LBP) volunteered for this study. Subjects were divided into two main groups: sitting and standing. The sitting group consisted of twenty subjects selected from a population of employees whose jobs required sitting behind a desk for a period not less than seven hours a day. The standing group consisted of another twenty subjects who were selected from recruits who worked as traffic wardens, hence spent all their shifts (nearly eight hours a day) in the standing position. All subjects reported a complaint of LBP, which was further classified as non-pathological by clinical investigations.

Instrumentation

A computer-controlled isokinetic triaxial dynamometer (model Isostation B-200, Back evaluation system, Isotechnologies Inc., Enraf Nonius, The Netherlands) was used to evaluate and train the subjects participating in the study. The system incorporates a force acceptance unit which interfaces the subject with the system, a lever arm which provides the base for the force acceptance unit which moves radially about a fixed axis, a load cell which converts the force into an electrical signal, a plate serving to position the subject and, a control unit consisting of a personal computer (IBM compatible, 486, 25 MHz) and its associated peripheral equipment. Position, torque and velocity are simultaneously recorded in each primary and secondary plane of movement and digitized at a sampling rate of 450 Hz.

Protocol

All subjects were first familiarized with the experiment and its purpose and were allowed at least four practice trials at each resistance level. Measurements were made while subjects stood on the elevated footstand, facing out of the Isokinetic system. After performing the standard positioning procedures, subjects were restrained using the provided straps and pads at the levels of the pelvis, thighs and thorax.

Once secured in the isokinetic system, subjects were oriented about their arm placement and posture during the session. Arms were to be folded across the chest just below the chest pad and kept close to the body. In addition, They had to initiate all motions from their trunk without using other body segments to assist with their performance. Subjects' cooperation was motivated by continuous follow-up and encouragement.

Three types of tests were conducted on both groups, namely range of motion (ROM), isometric and dynamic tests. During ROM tests, subjects were instructed to move as far as possible with minimum resistance set by the 8-200 system. Isometric tests, however, required maximal efforts against a mechanically locked system. During dynamic testing, subjects performed five repetitions about each of the three axes of motion of the spine (antero-posterior and lateral) as hard and fast as possible. Dynamic resistance was set at 25% and 50% of the MIT with the order reversed in a second test sequence.

During the rehabilitation program, each subject performed a strength protocol consisting of dynamic exercises in a pain-free ROM. Dynamic resistance was based on the MIT each subject can generate. Each subject received the same isokinetic training program three times per week for four consecutive weeks. Each day of the strength protocol involved the same twelve exercises, which are described in table (1).

Table (1):

Exercise/Axis	Resistance	Repetitions	Exercise time	Resistance time
1-Lateral flexion	25%	20	120 sec	30 sec
2-Lateral flexion	25%	20	120 sec	60 sec
3-Flexion/Extension	25%	20	120 sec	30 sec
4-Flexion/Extension	25%	20	120 sec	60 sec
5-Rotation	25%	20	120 sec	30 sec
6-Rotation	25%	20	120 sec	60 sec
7-Lateral flexion	50%	12	120 sec	30 sec
8-Lateral flexion	50%	12	120 sec	60 sec
9-Flexion/Extension	50%	12	120 sec	30 sec
10-Flexion/Extension	50%	12	120 sec	60 sec
11-Rotation	50%	12	120 sec	30 sec
12-Rotation	50%	12	120 sec	60 sec

DATA ANALYSIS

In order to check the progress in the isokinetic data collected along the course of the isokinetic training program statistical comparison was made for each group using one way analysis of variance (ANOVA). Independent t-test was applied between the two groups (standing and sitting). The level of significance was $P<0.05$

RESULTS

Analysis of the results showed that the subjects in both groups exhibited a significant improvement in their condition after the treatment program. Assessment is based on the isokinetic parameters measured before the commencement and along the course of the training program (five evaluation sessions).

Maximum Isometric Torque "MIT"

Among the standing group, there was a significant increase ($P<0.05$) in the extension torque than in the flexion torque, at the same time subjects also exhibited a significant increase in their MIT of right rotation and right lateral flexion than the left rotation and lateral flexion.

In the sitting group the significant increase($P<0.05$) in the torque was observed in flexion more than in extension and in right lateral flexion more than left lateral flexion. While there was insignificant change in rotation to right or to left.

Dynamic Average Torque "DAT"

From the study it was clear that when the program was applied at 25% and 50% of MIT the torque exerted during rotation, flexion, extension and lateral flexion was significantly ($P<0.05$) higher in the standing group than in sitting group.

Dynamic Maximum Velocity "DMV"

From the results of this study, the dynamic maximum velocity at 25% of MIT differed from that at 50% of MIT. At 25% of MIT, it was observed that there was a significant increase in the velocity during flexion, lateral flexion to the right and to the left in standing more than in sitting groups. In the other variables, i.e. rotation to the right and left and extension of the trunk there was no significant change in the velocity between the standing and sitting group.

At 50% of MIT, the reverse action occurred as the dynamic maximum velocity increased significantly in the sitting group more than in standing group for rotation, flexion, extension and lateral flexion to the right and to the left.

Range of Motion "ROM" of the trunk

From the results of the study, it was observed that the significant increase in the trunk ROM appeared in the standing group in the following motion, left rotation, flexion and left lateral flexion more than right rotation, extension and right lateral flexion respectively.

There was no significant changes between standing and sitting groups in ROM of trunk lateral flexion and flexion. In extension and left rotation, the standing groups showed significantly increase in their ROM more than in sitting group. In trunk right rotation, siting group had significantly higher ROM than standing group.

Pain

All subjects in both groups reported a reduction in the degree of pain felt at low back towards the end of the training program. The level of pain was quantified using the visual analogue scale "VAS". The sitting group enjoyed more pain relief than in the standing group.

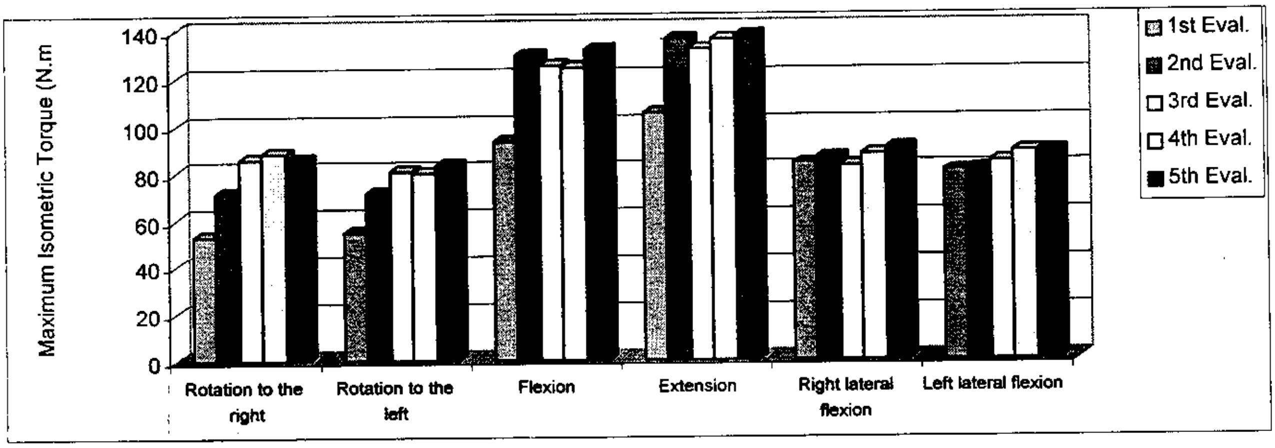

Fig. (1): Histogram showing the MIT recorded in five evaluation sessions in different trunk positions of subjects in the standing group.

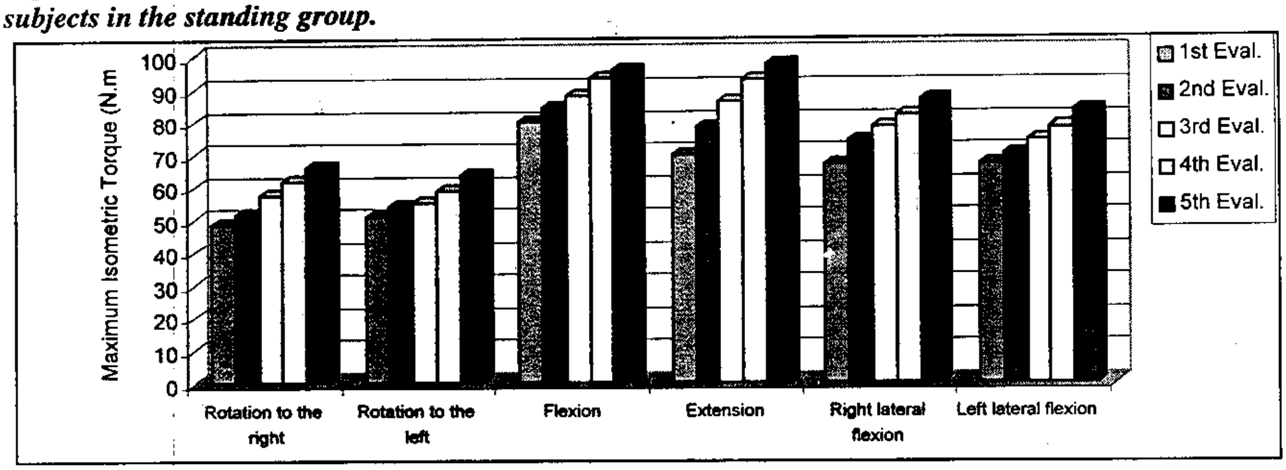

Fig. (2): Histogram showing the MIT recorded in five evaluation sessions in different trunk positions of subjects in the sitting group.

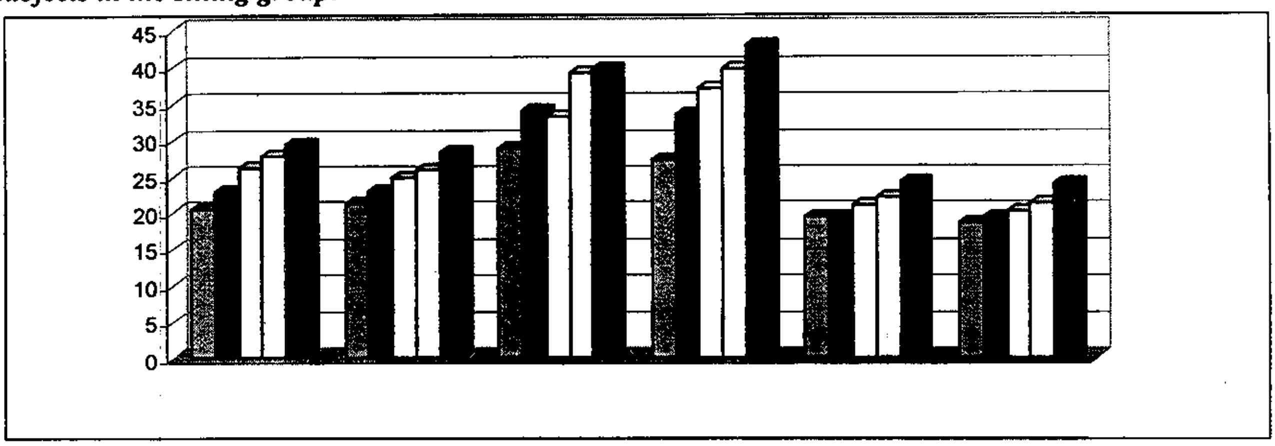

Fig. (3): Histogram showing the dynamic average torque at 25% of MIT recorded in five evaluation sessions in different trunk positions of subjects in the standing group.

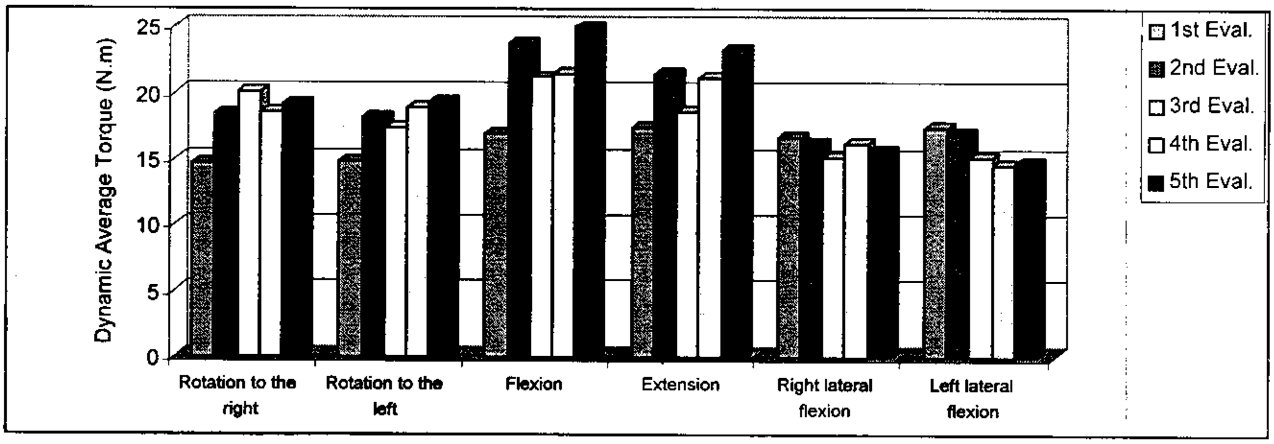

Fig. (4): Histogram showing the dynamic average torque at 25% of MIT recorded in five evaluation sessions in different trunk positions of subjects in the sitting group.

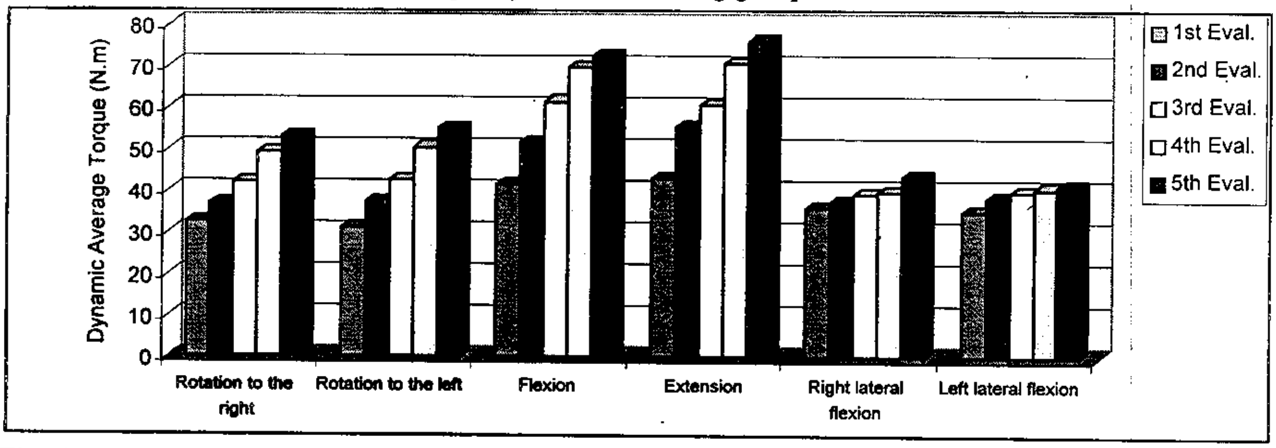

Fig. (5): Histogram showing the dynamic average torque at 50% of MIT recorded in five evaluation sessions in different trunk positions of subjects in the standing group.

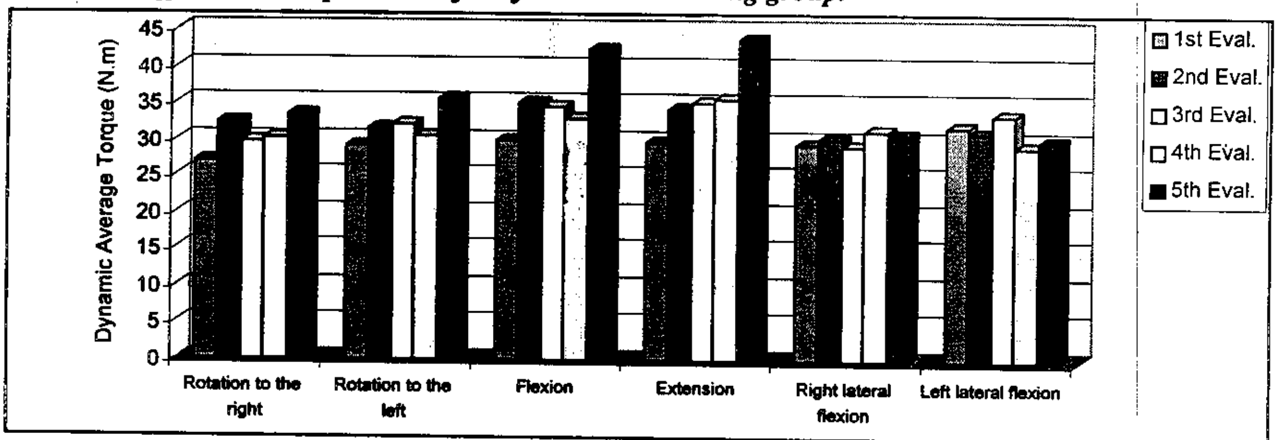

Fig. (6): Histogram showing the dynamic average torque at 50% of MIT recorded in five evaluation sessions in different trunk positions of subjects in the sitting group.

DISCUSSION

Maximum Isometric Torque "MIT"

The differences reported between the two groups could be attributed to the nature of activities, which are carried out by people working in standing. They are expected to actively load their muscles to execute any task. Therefore they are expected to have a higher base line in the intensity of their muscle torque than those individuals who work most of their time sitting.

Malcaire and Masset[18] investigated the relation between low back pain and MIT. Their findings showed that subjects with low back pain have a significantly reduced isometric performance. Based on their findings they pointed out that the reduction in isometric performance of subjects with low back pain suggests some impairment of the muscles, impairment that could alter the tension-length relationship I n different postures. They also added that different postures lead to modifications in the distribution of forces on the intervertebral disks, the apophyseal joints and the ligaments. Any alteration of these structures also could influence the behavior of the trunk and its performance, depending upon the adopted posture.

The significant increase in muscle torque of both group of subjects can be attributed to adaptive changes in the muscles or muscle control. This is in agreement with Esselman et al.,[11] who stated that the critical variable for developing strength (maximal torque) within the isokinetic training is the amount of torque developed during training. In their study Esselman and co-workers trained twenty subjects on a Cybex II isokinetic dynamometer in which they performed maximal voluntary isokinetic concentric knee extensions. They concluded that the neural factor which contribute to strength gain in any training program could be attributed to the increased level of recruitment and increased synchrony. In addition muscle can adapt to a strength training program with hypertrophy or enzymatic activity of glycolytic and mitochondrial enzymes.

Increasing flexion torque more than extension can be attributed to increased activity of abdominal muscles (rectus abdominus) in addition to psoas muscle torque. This results are in agreement with a study by McGill,[21] who pointed out that rectus abdominus has a potential to act as a powerful flexor of the trunk in addition to most superior laminas of psoas muscle which reserved polarity from being a very weak extensor in the upright posture to a flexor in the extremely flexed posture.

This is also in agreement with the study of Takemasa et al.,[27] who studied the effect of trunk muscles exercises on patients with LBP and concluded that the extensor strength was more significantly reduced more than the flexor strength.

In contrast to these finding, the results of Saur et al.,[25] were in disagreement with this study, the authors studied the isokinetic strength of lumbar muscles in patients with chronic backache and concluded that the isokinetic strength of the lumbar extension muscles was higher than the strength of the flexor muscles. The variations in different studies may be due to the great variation in methods, procedures, equipment, type of contraction and subjects. As stated by Takemasa et al.,[27] that even if trunk muscle strength is measured using the same test protocol and compared for normal and back pain subjects, the subjects and their physical or pathological condition may differ in each study.

The correlation between isometric trunk extension effort and integrated electromyographic activity was conducted previously by Alexiev,[3] on low back muscles during straight position and concluded that strength/EMG relationship was close to linear in normal whereas it was nonlinear in patients therefore in patients a smaller tension correlated with relatively higher muscle activity.

Dynamic Average Torque "DAT"

The result can be explained by the fact that individuals working in standing situation are constantly exposed to move their trunk and consequently gaining higher trunk flexibility than in individuals working in sitting situation. Flexibility of the trunk is associated with increased muscle strength and hence increased dynamic muscle torque[12]. Individuals working in sitting position (office work) move their trunk dynamically less with consequent diminution of trunk flexibility and muscle strength. Therefore, despite their dynamic torque improved through the isokinetic training program, still the dynamic torque exhibited by this group of subjects was significantly less than that of the standing group. This agreement is consistent with the view of Esselman et al.,[11] who postulated that torque gains in response to training are caused by adaptive changes in muscle or neural control. The authors also pointed out that muscle can adapt to a strength training program with hypertrophy or enzymatic changes.

Similarly, it was observed that in standing group the torque exerted during extension at 25% and 50% of MIT was significantly higher than the torque exerted during flexion. This is can also be attributed to the position assumed by the standing subjects. As during standing the normal alignment of line of gravity is in front of the second sacral vertebra, so creating a forward flexion moment tending to pull the body forward. As a normal compensatory mechanism, the trunk extensors muscles develop torque and produce a backward extension moment to counterbalance the forward bending moment. As a result the torque observed during the study at 25% and 50% of MIT was higher in extension than in flexion.

On the contrary, the dynamic average torque at 25% of MIT in sitting group showed significant increase in flexion torque more than extension. This can be attributed to the posture adopted by the subjects in sitting group and its effect on the muscular activity. Many people assume sagging position during sitting loading to decreased activity of the erector spinae muscles and trunk extensors. As a result the trunk flexor activity increased their activity significantly more than the extensors.

Dynamic Maximum Velocity "DMV"

The difference observed between the dynamic maximum velocity at 25% and 50% of MIT can be attributed to the increase in the amount of trunk maximum isometric torque. As stated by Enoka,[10] there is indirect relationship between muscle torque and velocity of motion. As the torque increases the velocity of action decreases that is why, as the torque increases from 25% to 50% of MIT the dynamic maximum velocity of trunk motion decreased significantly whether in the standing or in the sitting group.

The differences observed between the standing and sitting groups at 50% of MIT can be attributed to the significant increase in the dynamic average torque at 50% in the standing group more than in sitting group.

However, Esselman et al.,[11] investigated the development of torque in isokinetic training during maximum knee extension. Analysis of their results showed that torque-velocity relations indicated that subjects who trained at 360/sec made significant overall gains in torque and significantly greater torque gains than this training at 1080/sec. These results are consistent with the findings of this study in relation to torque and velocity.

The results of this study is also in agreement with Masset et al.,[20] who stated that dynamic parameters of the trunk such as the velocity have been shown to be significantly reduced for low back pain in workers in cross sectional studies. They concluded that although workers with a history of LBP performed dynamic tests At significantly lower velocities, the probability for development of LBP in the following year is greater for workers performing such tests at greater velocities.

Range of Motion "ROM" of the trunk

From the results of ROM and torque exerted by the trunk muscles, it is appeared that there is inverse relationship between trunk ROM and torque. This can be explained by the torque angle relationship as stated by Enoka[10] can be ascending, descending or ascending-descending relationship. From these results, the trunk muscles obeys the descending relationship, the ROM decreases as the torque increases.

The asymmetry of trunk motion observed in this study is consistent with the study of Gomez[12] who believed that asymmetry of trunk motion plays a significant role in the development and presentation of low back pain. In his study, he tested rotation, lateral flexion, active ROM and isometric strength in subjects with and without LBP. A similar pattern of asymmetry was found in both groups, however the magnitude of ROM asymmetry was significantly greater for the LBP subjects. The asymmetry observed in the LBP population may be an augmented expression of normal asymmetrical performance and behavioral factors may play a role in this expression.

The loss of asymmetrical movement may also not be related directly to constraints or irritation of the contractile element under stress. If this were the case, it would be expected that both passive stretch and active contraction stresses would result in related restrictions. This is further supported by the fact that bilateral paraspinal EMG measurements in LBP patients have not revealed significant asymmetry. IT has been suggested that most patients will list away from the side of symptoms[23].

Clinical presentation of asymmetry such as lateral shift could indicate a specific mechanical abnormality in an individual patient. As reported by Adams and Hutton[2] that the center of rotation during in vivo rotation varied widely from test to test. As a result of the complex system of performance synergy in the spine, functional units tend to cross many barriers of anatomic structure. Because of the number of functional units involved in most gross movement, there is a great adaptive potential that may allow for normal function even if one or more functional units are impaired[24].

The movement of rotation and lateral flexion is coupled mechanically in the lumbar spine so that a lateral flexion moment is converted into a rotational moment by the lordotic curve and the orientation of the facets[12]. Gomez concluded that greater flexibility was only observed in rotation, the force required to overcome resistance of the apparatus and soft tissue restraints in rotation is not gravity-assisted, as it is in lateral flexion.

The increase in ROM observed in this study after the exercise program was most likely due to giving the patients confidence to move in spite of their pain. This is consistent with the study of Magnusson et al.,[17] who concluded that functional rehabilitation increases motion and velocity, this may occur because of the increased activity involved in the program, decreased inhibition resulting from stretched muscles, and improved motor control skills. The patient's confidence is increased because he experiences less pain, improved skills and the insight that motion is good.

The level of Pain

Also this result could be due to the fact that in the sitting group the subjects are more relaxed and the trunk muscles are not subjected to high level of activity. But in standing group, subjects are less relaxed in sitting group and the trunk muscle are sufficiently active to maintain the body in its erect position leading to production of more pain than in the sitting group.

As reported by Keller et al.,[13] that self-efficacy for pain is the most powerful predictor of trunk muscle strength in patients with LBP, patients in this study were informed to describe and record their level of pain after the isokinetic program. The observed reduction of pain after the program is in agreement with Deutsch[6] who recorded increased average lumbar strength and decrease in pain after isolated lumbar strengthening program in chronic LBP.

In addition Takemasa et al.,[27] concluded from their study that trunk muscle exercises reduced low back pain in chronic LBP patients. The degree of correlation between increase in trunk muscle strength and improvement of LBP was high in the group of LBP patients who had no detectable organic lesion than in the group of LBP patients who had detectable organic lesion.

Flexion strengthening program was recommended by Williams for treating and relieving LBP, while McKenzie recommended extension exercises. These authors used different training programs but both reported success in reducing LBP[22].

CONCLUSION

This study demonstrates that certain isokinetic training programs can be very effective in rehabilitating patients suffering from nonpathological low back pain regardless of their working habits. However, subjects whose typical working days involve dynamic activities undertaken from a standing posture have shown better response than the ones with less activity represented by the sifting group. This was reflected from the apparent substantial improvement in the muscle torques of the standing group. Meanwhile, in the sitting group, the isokinetic program proved to be more effective in improving speed of motion, range of motion and alleviating pain.

REFERENCES

1- Adams, J.C. and Hamblen, D.L.: "Outline of Orthopaedics". Eleventh Edition, ELBS, Churchill Livingstone, Medical Division of Longman Group Great Britain, Beccled. pp: 142, 148-156, 1991.

2- Adams, M. and Hutton, W.: "The Relevance of Torsion to the Mechanical Derangement of the Lumbar Spine". Spine (6): 241-248, 1981.

3- Alexiev, A.R.: "Some Differences of the Electromyographic Erector Spinae Activity between Normal Subjects and Low Back Pain Patients during the Generation of Isometric

Trunk Torque". Electromyography. Clin. Neurophysiol. Dec. 34 (8): 49 5-499, 1994.

4- Astrand, P.O. and Randahl, K.: "Textbook of Work Physiology, Physiological Bases of Exercise". 3rd Edition. Philadelphia, 1986.

5- Cartas, 0.; Nordin, M.; Frankel, V.H.; Malgady, R. and Sheikhzadeh, A.: "Quantification of Trunk Muscle Performance in Standing, Semistanding and Sitting Postures in Healthy Men". Spine; Volume (18), NumberS, pp: 603-609, 1993.

6- Deutsch, F.E.: "Isolated Lumbar Strengthening in the Rehabilitation of Chronic Low Back Pain". J. Manipulative Physiol. Ther., Feb. 19(2): 124-733, 1996.

7- Deyo, R.A. and Tsui-Wu, Y.J.: "Descriptive Epidemiology of Low Back Pain and its Related Medical Care in the United States". Spine 12:264, 1987.

8- Dul, J. and Weerdmeester, B.A.: "Ergonomics for beginners". A quick reference guide Taylor and francis,London, 1994.

9- Dvir, Z.: "Isokine tics: Muscle Testing, Interpretation a
Edinburgh, Churchill Livingstone, 1995.

10- Enoka, R.M.: "Neuromechanical Bases of Kinesiology". Human Kinetics Books, Champaign, USA, 1988.

11- Esselman, P.C.; deLateur, B.J.; Alquist, A.D.; Questad, K.A.; Giaconi, R.M. and Lehman, J.F.: "Torque Development in Isokinetic Training". Arch. Phys. Med. Rehabil. Vol. 72: 72 3-728, 1991.

12- Gomez, T.T.: "Symmetry of Lumbar Rotation and Lateral Flexion Range of Motion and Isometric Strength in Subjects with and without Low Back Pain". J. Orthop. Sports Phys. Ther., Jan. 19(1): 42-48, 1994.

13- Keller, A.; Johansen, J.G.; Hellesnes, J. and Brox, J.I.: "Predictors of Isokinetic Back Muscle Strength in Patients with Low Back Pain". Spine Feb. 1;24 (3): 275-280, 1999.

14- Lamb, D.R.: "Physiology of Exercise; Responses and Adaptations". Printed in the United States, 1984.

15- Lancourt, J. and Kettelhut, M.: "Predicting Return to Work for Lower Back Pain Patients Receiving Worker's Compensation". Spine 17: 629, 1992.

16- Lehman, T..R.; Spratt, K.F. and Lehmann, K.K.: "Predicting Long Term Disability in Low Back Injured Worker's Presenting to a Spine Consultant". Spine 18:1103, 1993.

17- Magnusson, M.L.; Bishop, J.B.; Hasselquist, L.; Spratt, K.F.; Szpalski, M. and Pope, M.H.: "Range of Motion and Motion Patterns in Patients with Low Back Pain before and after Rehabilitation". Spine, Dec. 1;23 (23): 2631-2639, 1998.

18- Malchaire, J.B. and Masset, D.F.: "Isometric and Dynamic Performances of the Trunk and Associated Factors". Spine Aug. 1:20 (15): 1649-1656, 1995.

19- Marras, W.S. and Mirka, G.A.: "A Comprehensive Evaluation of Trunk Response to Asymmetric Trunk Motion". J. Spine, Vol. 17, No. 3, pp: 318-326, 1992.

20- Masset, D.F.; Piette, A.G. and Malchaire, J.B.: "Relation between Functional Characteristics of the Trunk and the Occurrence of Low Back Pain. Associated Risk Factors". Spine, Feb. 1;23 (3): 359-3 65, 1998.

21- McGill, S.M.: "Kinetic Potential of the Lumbar Trunk Musculature about Three Orthogonal Orthopaedic Axes in Extreme Postures". Spine Vol. (16), No (7): 809-815, 1991.

22- Mckenzie, R.A.: " The Lumbar Spine :Mechanical Diagnosis And Therapy". Wiakanae,New Zealand,Spinal Publications, 1981.

23- Nouwen, A.; Akkerveeken, P. and Versloot, J.: "Patterns of Muscular Activity during Movement in Patients with Low Back Pain". Spine 12: 777-782, 1987.

24- Porter, R. and Miller, C.: "Back Pain and Trunk Test". Spine (11): 59 6-600, 1986.

25- Saur, P.; Koch, D.; Steinmetz, U.; Straub, A.; Ensink, F.B.; Kettler, D. and Hildebrandt, J.: "Isokinetic Strength of Lumbar Muscles in Patients with Chronic Backache". Z. Ort hop.

Ihre. Grenzgeb. Jul-A ug; 135(4): 3 15-322, 1997.
26- Scudds, R.A.: "Pain Assessment". The Australian J. of Physiotherapy, 29 (3): 96-102, 1983.
27- Takemasa, R.; Yamamoto, H. and Tani, T.: "Trunk Muscle Strength in and Effect of Trunk Muscle Exercises for Patients with Chronic Low Back Pain". Spine. Vol. 20, No. 23, pp 2522-2530, 1995.
28- Thompson, N.N.; Gould, J.A. and Davis, G.J.: "Descriptive Measures of Isokinetic Trunk Testing". Journal of Orthopedic and Sports Physical Therapy 7: 43-49, 1985.

الملخص العربي

عزم عضلات الجذع ثلاثي المحور في الأشخاص الذين يعانون من آلآم أسفل الظهر

صـــممت هـــذه الدراسة لبحث وتحليل تأثير التدريبات ذات المقاومة الايزوكيناتيكية المتغيرة على عزم عضلات الجذع ثلاثي المحور في الأشخاص ذوي الحالات الوظيفية المختلفة وقد اختير في هذه الدراسة ٤٠ شخص يعانون من ألام أسفل الظهر ميكانيكيا (أي بدون إصابة) مقسمين إلى مجموعتين كل مجموعة ٢٠ شخص . إحدى المجموعتين تتطلب طبيعة عملها الوقوف لفترة طويلة ، أما الثانية تتطلب طبيعة عملها الجلوس لفترة طويلة . وتتراوح أعمار كل مجموعة بين ٢٠-٢٧ سنة . وكان الهدف من إجراء البحث هو المقارنة بين المجموعتين من حيث عزم عضلات الجذع في الثلاث محاور والسرعة الزاوية ومدى الحركة والإحساس بالألم . ويتم أولا تقييم قوة العضلات في كل اتجاه باستخدام جهاز مخصص لهذا الغرض كما يتم تقييم السرعة الحركية للجذع ، والمدى الحركي للجذع ويسجل أيضا لكل شخص مدى الإحســاس بالألم أسفل الظهر . يتم وضع البرنامج بناءا على أقصى قوة عضلية يسجلها الجهاز في كل اتجاه بحيث تؤخذ ٢٥% و ٥٠% فقــط مــن أقصــى قوة عضلية ويتم تكرار كل حركة في كل اتجاه . ثم يكرر البرنامج ثلاث مرات أسبوعيا ولمدة أربع أسابيع ، ثم تقييم الشخص مرة كل أسبوع . وكانت النتائج الخاصة بكل شخص تسجل على الكمبيوتر .

وقــد أكدت النتائج على أن الأشخاص الذي يتطلب عملهم الوقوف لفترات طويلة يستجيبوا بدرجة أكبر من المجموعة الذين يجلسون أثناء العمل لفترات طويلة كما أثبتت القياسات . كما لوحظ نقص في السرعة الزاوية القصوى في مجموعة الوقوف عن مجموعة الجلوس ، كما وُجدت علاقة عكسية بين المدى الحركي للجذع وعزم القوة العضلية . كما أن الألم قد قل المنطقة القطنية للعمود الفقري بصفة ظاهرة في البرنامج التدريبي لكل من المجموعتان ولكنه أكثر في المجموعة التي تجلس لفترات طويلة أكثر .