Electromyographic Study of The Paraspinal Muscles in Post Laminectomy Syndrome

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ABSTRACT

The purpose of this study was to compare the Electromyographic (EMG) findings of the paraspinal muscles in normal and post- laminectomy (L_4 - L_5 & L_5- - S_1) syndrome patients during performance of four different tasks namely, standing, sitting, bending the trunk and rising again from bending. Twenty male patients with post- laminectomy syndrome suffering from recurrent low back pain of duration of six months to two years participated in this study. The results were compared to those of a control group of twenty normal subjects with no history of low back pain. The (EMG) pattern of the post laminectomy group revealed a significant increase in (EMG) activities due to paraspinal muscles dysfunction in standing and sitting whereas (EMG) activities significantly decreased in bending of the trunk and rising from bending compared to the control group. These findings may be attributed to paraspinal muscles weakness following surgery. Thus, Physiotherapy programs should be concerned with full assessment of post-laminectomy low back patients and forming treatment protocols aiming to strengthening and endurance of paraspinal muscles.

INTRODUCTION

Post-laminectomy syndrome (PLS) or "Failed back syndrome" is persistent or recurrent pain after at least one previous lumbar surgery[20]. It has been called one of the most catastrophic problems in clinical medicine today[21]. The causes of failed back syndrome are continious neural encro-achment, mechanical instability, arachnoditis and perineural scarring[6]. Recurrance of symp-toms ranges from immediate failure, early recurrance (days, weeks) mid term recurrance (weeks, months) and late recurrance (months, years)[11].

The paraspinal muscles play a vital role in the stability and functional movements of the vertebral column, but their role in spinal dysfunction is unclear[23]. Spinal pain is the most common complaint of patients presenting with musculoskeletal problems[19].

The average paraspinal integrated EMG amplitudes have been studied in chronic low back pain (CLBP) during rest and various static postures in several studies. Consistant descriptions of integrated EMG differences in (CLBP) patients and healthy normal subjects at rest have not been established. Every possible result has been reported in the literatures[14]. Relative control subjects, (CLBP) patients have been found to exhibit elevation in integrated EMG[5], similar integrated EMG[18],

and lower integrated EMG[7]. Arena et.al.[3], found that EMG taking during various static postures can discriminate between (CLBP) patients and control subjects. They found that different types of (CLBP) had different patterns of elevated EMG. (CLBP) patients with disc disorders could be discriminated by higher EMG level during sitting position relative to controls and other types of (CLBP) patients.

Laminectomy for disc lesion has showed a wide progression in operative approach and so many factors were expected to cause the post-laminectomy pain (PLP). The paraspinal muscular condition may be one of these factors[6].

The purpose of the present study was to compare the EMG activities of lower lumbar paraspinal (LLPS) muscles of normal and post laminectomy patients during performance of different tasks.

MATERIAL AND METHODS

A) Subjects:

Fourty male subjects of an age ranging between 30 and 48 years were studied as two equal groups (study group and control group). The study group included 20 male patients with Post-laminectomy pain. The operation was done six months to two years perior to the onset of the study. They were selected from the Physical Therapy out clinic of Kasr EL-Aini Hospital, El-monera Hospital, EL-Agouza and EL-Shortah Hospitals. The control group included 20 male normal subjects with no history of previous or recurrent LBP, and were not participating at any special physical activity for their lumbar muscles. All subjects of both groups were selected randomly from different jobs with the average height and weight of 180 cm. and 84 kg. respectively.

B) Instrumentations:

a) A Tonnies "four" channels myograph was used to measure the EMG activities of the paraspinal muscles.

b) A revolving chair covered with washable black leathere adjustable in height from 45-60 cm.

c) Adjustable Plurimeter -V- inclinometer for measurment of forward bending the trunk (30°). It was modified by connecting to it an elastic strap with three hooks to suit the diameter of the patient's trunk and to maintain stability of the device during measurement.

d) Stop watch was used to measure the five minutes of maintaining relaxed standing and sitting positions before EMG recording.

C) Procedures:

For recording the muscle activities : Tonnies needle electrodes were applied after sterilization, prior to each use to reduce the impedance or internal noise. The anatomical level of L_4-L_5 & L_5-S_1, intrespace was identified and marked. The electrode site was determined three cm. lateral to the interspace to the right side as described by Andersson et al[2]. The ground electrode was moistened with saline and firmly fitted around the right wrist of the subject. The skin at the lumbar area was cleaned by alcohol and the needle electrode was inserted after explaining the study to the subjects. Each subject was then asked to perform four activities, the first two of them regarding the postural tone of the (LLPS) muscles. The other two tasks regarding the muscular activity during motion. The EMG findings were recorded during the task after repetition of each motion three times.

a) Standing upright position, both feet apart, arms beside the body and the subject be relaxed as much as he can. The position was sustained for five minutes before EMG recordings to gain maximum relaxation.

b) Sitting without back support on the revolving adjustable chair to give right angles between the trunk and the thighs and between thighs and legs. This position was maintained for five minutes before EMG recordings to gain maximum relaxation.

c) Bending the trunk about 30°: The subject was asked to bend his trunk forward about 30° at a lumbar pelvic portion in a slow motion with counting from one to five at a rhythmical manner. The angle was measured using plurimeter-V-inclinometer which was supported at the level of lumbar region, and adjusted on zero, while both sides of its arms were kept in contact with the spine through an adjustable elastic strap. The subject was asked to lean forward 30° with both knees extended. The subject was then instructed to return to his starting position.

d) Rising again from bending position, the subject was asked to rise his trunk to the erect standing position in a slow motion, with counting from one to five at a rhythmical manner.

Data collection: The EMG signals were obtained by connecting the channel to the integrator through the preamplifier. The signals were amplified to 200 microvolt (μV) and for ten milliseconds (ms.) visually checked on the screen and then recorded on an oscillograph paper. The highest two amplitudes of the electrical activity were measured for the four tasks of each subject in (μV) then the mean was calculated.

Data analysis: The readings were fed into the computer for the statistical analysis. The mean, standard deviation were calculated for both groups for the four tasks. The correlated. T. test was done to compare between the means of the two groups. Alpha level at (.05) was used for significancy.

RESULTS

In the present study the EMG activities recorded from the (LLPS) muscles during performing the four tasks for both groups were compared. As shown in table (1) the mean value of the EMG activities of the post-laminectomy group during standing position was (578.5 μV) higher than the mean value of the control group which was (410 μV). The comparison between the two groups revealed a significant difference P(0.0002). As observed from table (2), comparison of the mean values of the paraspinal muscles EMG activities in both groups during sitting position without support revealed a higher mean value in the study group (355.5 μV) than that of the control group (205 μV). The comparison between the two groups showed a significant difference P(0.0001). In the present study the comparison between the two groups regarding the postural tone of the LLPS muscles during standing and during sitting positions was increased significantly for the PLS patients than the normal subjects as presented in tables (1 & 2) and fig. (1).

Table (1): Comparison between the mean values of the EMG activities of the PSM for both groups (study & control) during standing / μV.

Group	EMG activities / μV	statistical comparison	
		T. value	P. value
Study	$\bar{x}$ 578.5 SD. ± 181.14	3.7756	0.0002*
Control	$\bar{x}$ 410 SD. ± 83.79		

$\bar{x}$ = mean SD. = standard deviation * significant.
PSM = Paraspinal muscle. / μV = in microvolt

Table (2) : Comparison between the mean values of the EMG activities of the PSM for both groups (study & control) during sitting / μV.

Group	EMG activities / μV	statistical comparison	
		T. value	P. value
Study	$\bar{x}$ 355.5 SD. ± 129.31	4.9804	0.0001*
Control	$\bar{x}$. 205 SD ± 39.27		

* Significant.

Inspection of table (3) revealed that the mean value of the EMG activities during bending the trunk in the study group was 954 μV lower than that in the control group which was 1345.5 μV. The difference was statistically significant P(0.0001). In table (4) comparison between the mean values of the EMG activities of the LLPS muscles during rising the trunk again from bending position for both groups showed that the mean value in the study group was 911 μV lower than that in the control group which was 1164 μV. The comparison between the two groups revealed a significant difference P(0.0001).

In the present study, as illustrated in tables (3 & 4) and fig. (1), the EMG activities of the LLPS muscles during the movements (bending & rising) were much lower in the PLS patients than that in the normal subjects.

Table (3): Comparison between the mean values of the EMG activities of the PSM for both groups (study & control) during bending of the trunk / μV.

Group	EMG activities / μV	statistical comparison	
		T. value	P. value
Study	$\bar{x}$ 954 SD. ± 180.03	6.2277	0.0001*
Control	$\bar{x}$ 1345.5 SD. ± 22.44		

* Significant

Table (4) : Comparison between the mean values of the EMG activities of the PSM for both groups (study & control) during rising from bending / μV.

Group	EMG activities / μV	statistical comparison	
		T. value	P. value
Study	$\bar{x}$ 911 SD. ± 137.22	3.89	0.0001*
Control	$\bar{x}$ 1164 SD. ± 255.62		

* Significant

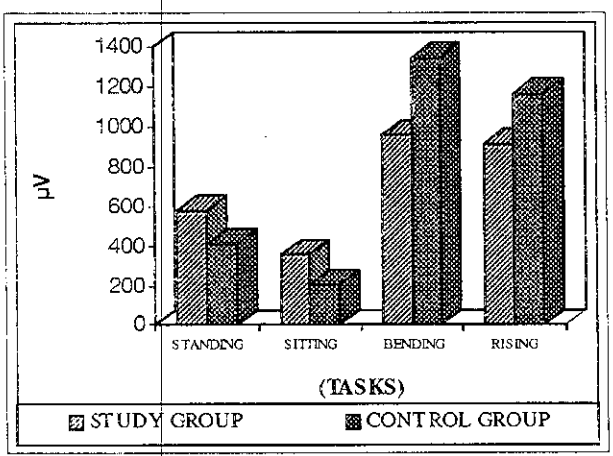

Fig. (1) : Mean values of the EMG activities of the (PSM) for both groups (study & control) during standing, sitting, bending & rising from bending / μV.

DISCUSSION

The results obtained from the present study demonstrated evidence that the EMG activities of the LLPS muscles increased significantly in the PLS patients than in normal subjects during the static posture. Also during dynamic movements of the trunk the EMG activities of the same muscles significantly decreased in the study group than in the control group. Many factors may be attributed to the elevation of the EMG activities of the LLPS muscles during the static posture: **a)** The mechanical disadvantage of the vertebral column after excision of the lamina may give an increased tension of the lumbar muscles[12] and due to increased recruitment levels of a set number of motor units, which would require a rise in their frequency or recruitment of a large proportion of the available motor unit pool[9], **b)** The presence of CLBP after the operation may support conne-ction that pain producing tension leads to more pain[16].

These findings are in agreement with Donovan[10] & Kraft[17], who found an increase in the EMG activities of the paraspinal muscles (PSM) during the first six months after laminectomy. Similarly Aherm et al[1]. reported an increase in the EMG activities of the PSM during the static posture (standing) in patients with back surgery at the lower lumbar region. Many other investigators found an increase of the EMG activities during the static posture in chronic LBP patients.

Budznsk et al[5] found a positive correlation between the increase of the EMG activities of the back muscles and the degree of pain. Nouwen, and Bush[25] also Jones, and Wolf[15] recorded EMG abnormalities for those patients with chronic LBP and described these abnormalities and the increased muscle tension. Also Sherman[22] recorded that, an increase in the EMG activities of the PSM in chronic LBP patients which significantly increased the activities during standing. These findings agree with Hoyt et al.[13] and kravitz et al.[18]. Cooper et al.[9] who suggested that, the elevation of the EMG activities induced in LBP reflect the incease of central drive required to maintain the isometric force in the face of increasing the peripheral fatigue resulting from activity-induced metabolic and electrical disturbances within the muscles. Central drive was clearly greater in post surgical LBP patients than in normal subjects. This demonstrates that the limiting factor in the patients was not inhibition due to fear of pain or lack of motivation[9].

The PSM denervation is known to occur and may persist for very long periods after lumbar laminectomy. In the most serious cases striking denervation atrophy of low back muscles occurs in injuried segments, leading to loss of functional muscle support and to disturbed segmental mobility and further increased biomechanical strain and stability[24].

As the PSM denervation causes wasting, denervation also leads to fiber grouping owing to reinnervation change[7]. To optimize function in denervated muscles the LBP patients may have developed "nonphysiologic" central activation pattern. They may have preferentially activated different parts of the same muscles, such as type (I) fibers or larger than normal groups of either fibre type, or activated more of the available muscles which could account for their integrated EMG changes. This may particularly apply to post surgical patients, who may have also suffered significant atrogenic biomechanical disadvantage due to loss of disruption of muscle insertion sites[8].

The significant decrease of the EMG activities of the PSM during movement of the spine (bending the trunk & rising again) in the post laminectomy patients revealed the state of the PSM of the back after surgery.

Jeffrey et al.[14] concluded that the high muscle tension (elevated integrated EMG) is predicated by a muscle spasm model, and low muscle tension (lowered integrated EMG) is predicated by a muscle difficiency model .

CONCLUSION

The results of this study demonstrated that the EMG recordings of the LLPS muscles increased significantly in the (PLS) patients than in normal subjects during the static posture. But during the dynamic movements of the trunk, the EMG recordings of the same muscles significantly decreased in the study group than in the control group. These results support strongly the effect of full assessment and the EMG recordings of post laminectomy LBP patients for the LLPS muscles.

Recurrent pain after laminectomy (PLS) may be due to the state of the PSM of the lumbar region, which become tense and weak. The low back operations can sometimes cause slight denervation and corresponding denervation atrophy in the back muscles. These results reflect the importance of physiotherapy including full assessments and rehabilitation for the strengthening and endurance of the PLS patients.

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الملخص العربى

إستخدام جهاز رسم العضلات الكهربائى لتقييم عضلات الظهر لمرضى أعراض ما بعد إستئصال الغضروف

فى هذه الدارسة تمت مقارنة بأستخدام جهاز رسم العضلات الكهربائى لعضلات الظهر الباسطة بالمنطقة القطنية بهدف تقييم حالة العضلات للمرضى الذين يعانون من أعراض آلام ما بعد جراحه إستئصال الغضروف .

وقد تم اختيار ٤٠ شخصا متوسط أعمارهم من ٣٠ الى ٤٨ عاما قسموا الى مجموعتين متساويتين (كل مجموعة ٢٠ شخصا) .

(أ) مجموعة المرضى : يعانون من أعراض آلام ما بعد إستئصال الغضروف جراحيا بالمنطقة القطنية .

(ب) مجموعة الأصحاء : لا يعانون من أى أعراض لآلام ولم تجرى لهم أى جراحة بالعمود الفقرى .

وقد تم تقييم للعضلات الباسطة للظهر بإستخدام جهاز رسم العضلات الكهربائى أثناء ممارسة أربعة أنشطة مختلفة (الوقوف – الجلوس – ثنى الظهر وفرده مرة أخرى) للمجموعتين . وقد أظهرت النتائج الأحصائية ما يلى : أن هناك زيادة معنوية فى النشاط الكهربائى للعضلات الباسطة للظهر أثناء وقوف وجلوس المريض دون سند للظهر ، كما أن هناك أيضا نقص ملحوظ فى النشاط الكهربائى لنفس العضلات أثناء ثنى وفرد الظهر للمجموعة (أ) بمقارنتها مع نتائج المجموعة (ب) وهذه النتائج ذات دلاله احصائية عالية جدا. ولذا نوصى بضرورة مصاحبة برامج العلاج الطبيعى للعمود الفقرى إجراء تقييم دقيق وشامل للمرضى الذين يعانون من عودة أعراض آلام ما بعد جراحة إستئصال الغضروف بالمنطقة القطنية للظهرمما يساعد على تقوية وزيادة قوة التحمل لعضلات العمود الفقرى ولما حققه من نتائج ذات قيمه إحصائيه عاليه .