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THE EFFECTS OF LAMINECTOMY SURGERY ON PAIN, FUNCTIONAL DISABILITY, SENSITIZATION AND ACTIVE TRIGGER POINTS IN SUBJECTS WITH LUMBAR DISC HERNIATION

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Objectives. To evaluate the effects of laminectomy surgery on pain, functional disability, sensitization and active trigger points in subjects with lumbar disc herniation.
Methods. This study was a prospective pre-post single group study. Seventy-one patients (42 male and 29 female) have been enrolled in the research with an age range of 20–60 (48 ± 13.41). During 48 hours before surgery, patients were examined by a physiotherapist. Pain intensity were measured by visual analogue scale, disability by oswestry index (Persian version) and sensitivity level using pressure algometer. Three month after laminectomy, the patients were re-examined for mentioned outcomes again.
Results. The majority of the patients (23 cases, 32.4 %) revealed 3 active trigger points of the muscles before surgery. 60 subjects (84.5 %) experienced a gradual onset of leg pain without a trauma history. Lumbar multifidus (74.9 %), medial gastrocnemius (73.2 %), soleus (70.4) gluteus medius (62 %) were the most involved muscles with trigger points before laminectomy. On the other hand, after laminectomy medial gastrocnemius (54.9 %), lateral gastrocnemius (53.5 %), soleus (50.7 %), multifidus (39.4 %) and quadratus lumborum (39.4 %) were the most involved muscles with trigger points. The existence of trigger points in longissimus thoracis (p = 0.04), quadratus lumborum (p = 0.001), gluteus maximus (p = 0.04) and tibialis anterior (p = 0.02) were decreased significantly after laminectomy. Pain, disability and pain pressure threshold revealed significant differences before and after surgery.
Discussion. The pattern of active trigger points of muscles was different before and after surgery. Multifidus and gastrocnemius were the most prevalent muscles with myofascial pain syndrome before and after surgery respectively.
Conclusion. The present study revealed that pain, disability, number and prevalence of trigger points decreased after lumbar laminectomy. Nevertheless, pressure pain threshold of trigger points increased after surgery. The pattern of active trigger points of muscles was different before and after surgery. Multifidus and gastrocnemius were the most prevalent muscles with myofascial pain syndrome before and after surgery respectively. In fact, current results showed that active trigger points should be considered before and after laminectomy surgery.

Keywords: lumbar stenosis, myofascial pain syndrome, trigger points, laminectomy, pain

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Влияние ламинэктомии на боль, функциональную нетрудоспособность, сенсибилизацию и активные триггерные точки у пациентов с грыжей поясничного диска

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Цель. Оценить влияние ламинэктомии на боль, функциональную нетрудоспособность, сенсибилизацию и активные триггерные точки у пациентов с грыжей поясничного диска.

Методы. В настоящее проспективное одногрупповое исследование до и после операции вошел 71 пациент (42 мужчины и 29 женщин) в возрасте 20–60 лет (48 ± 13,41). За 48 ч до операции пациентов осмотрел физиотерапевт. Интенсивность боли измеряли по визуальной аналоговой шкале, инвалидность – по индексу Освестри (персидская версия), а уровень чувствительности – с помощью альгометра давления. Через 3 мес после ламинэктомии пациенты были повторно обследованы с помощью указанных тестов.

Результаты. У большинства (23 случая, 32,4 %) пациентов до операции выявлены 3 активные триггерные точки в мышцах. У 60 (84,5 %) испытуемых наблюдалось постепенное зарождение боли в ногах без травм в анамнезе. Триггерные точки до ламинэктомии в основном присутствовали в поясничной многораздельной (74,9 %), медиальной икроножной (73,2 %), камбаловидной (70,4 %) и средней ягодичной (62 %) мышцах. С другой стороны, после ламинэктомии триггерные точки в основном были в медиальной икроножной (54,9 %), латеральной икроножной (53,5 %), камбаловидной (50,7 %), многораздельной (39,4 %) и квадратной поясничной (39,4 %) мышцах. Распространенность триггерных точек в длиннейшей мышце грудной клетки ($p = 0,04$), квадратной поясничной ($p = 0,001$), большой ягодичной ($p = 0,04$) и передней большеберцовой ($p = 0,02$) мышцах значительно уменьшилась после ламинэктомии. Признаки боли, инвалидизации и порог болевого давления выявили значительные различия до и после операции.

Обсуждение. Картина распределения активных триггерных точек мышц отличалась до и после операции. Наиболее часто миофасциальный болевой синдром до и после операции присутствовал в многораздельной и икроножной мышцах соответственно.

Заключение. Настоящее исследование показало, что боль, инвалидизация, число и распространенность триггерных точек уменьшились после поясничной ламинэктомии. При этом болевой порог давления на триггерные точки после операции повысился. Картина распределения активных триггерных точек мышц была разной до и после операции. Наиболее часто миофасциальный болевой синдром до и после операции присутствовал в многораздельной и икроножной мышцах соответственно. Фактически результаты настоящего исследования показали, что активные триггерные точки следует учитывать в период до и после ламинэктомии.

Ключевые слова: поясничный стеноз, миофасциальный болевой синдром, триггерные точки, ламинэктомия, боль

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INTRODUCTION

Low back pain arising from intervertebral disc herniation is a crucial cause of disability [1]. Approximately four hundred thousand people in the USA undergo lumbar disc surgery annually [2]. It has been demonstrated that about 60 % of lumbar disc surgeries leads to favorable outcomes [2, 3]. Inappropriate interpretation of MRI findings, spinal instability, and surgical complications are the most important reasons why these surgeries may lead to unfavorable outcomes [4, 5].

Myofascial pain syndrome is a chronic pain condition influencing musculoskeletal system [6]. It is characterized by trigger points along with non-throbbing pain ranging from mild to disabling pain [7]. Trigger point is a very sensitive point located in a taut band of skeletal muscle becoming painful due to pressure, tension, contraction and excessive loading [8]. The referral pain is also a main feature of the trigger points [9]. Trigger points are in two active and latent forms. Active trigger points are the cause of referral pain in 85 % of patients with musculoskeletal pain [7]. It has recently been shown that these points could be effective in creation and maintenance of regional pain such as headache, temporomandibular disorders, chronic pelvic pain syndrome, general pain such as fibromyalgia syndrome (FMS) or whiplash syndrome, and low back pain [10, 11].

Lumbar laminectomy is a cost effective surgical techniques for patients with lumbar spine stenosis [12, 13]. The lamina of the vertebrae is removed by a surgeon to decompress disc and nerve [13]. Muscles and soft tissues are damaged after surgery and may produce trigger points [14]. As well, some interventions are performed to eliminate trigger points after surgery [15]. Recently, some studies have been conducted on the occurrence of trigger points after various surgeries such as thoracic surgery or breast cancer surgery [16, 17]. A study by Lacomba et al found that 44.8 % of women who underwent breast cancer surgery had active trigger points in the shoulder and scapula muscles after one year of follow-up [16]. Also, Fernandez-Lao et al, showed active trigger points in neck and shoulder muscles after lumpectomy or mastectomy surgery [17].

However, to the best of our knowledge, no study has yet been performed on creation or disappearing of trigger points subsequent to laminectomy. In the present study, our aim

was to study the effects of laminectomy surgery on pain, functional disability, sensitization and active trigger points in subjects with lumbar disc herniation.

MATERIALS AND METHODS

We evaluated the patients before and after laminectomy surgery. Seventy-one patients (42 male and 29 female) have been enrolled in the research with an age range of 20–60 (48 ± 13.41). The patients suffering from back pain before and after laminectomy of fourth and fifth vertebrae were referred to physiotherapy center of poorsina hospital. This pre-posttest single group study was prospectively recorded at Clinicaltrials.gov with the clinical trial number: IRCT20170516034003N7. The study was approved by the research deputy of Guilan University of Medical Sciences (code of ethics: IR.GUMS.REC. 1396.344) and all patients signed the informed consent form. The patient's flow chart is shown in figure 1.

The inclusion criteria were: The subjects with unilateral chronic low back pain that radiate to lower limb, the pain duration was more than 3 months, the patients were selected for laminectomy surgery by a neurosurgeon and were hospitalized, the patients which had at least 1 trigger point in lumbar or lower limb muscles.

Subjects with following conditions or diseases have been excluded from the study: fibromyalgia, neuralgia, rheumatoid arthritis, lumbar and hip myopathy, neuropathy and myelopathy, cognitive disorders; cancer, cauda equine syndrome, receiving acupuncture or trigger point injection, pregnancy, abuse, receiving corticosteroids; surgery of other lumbar vertebrae; urinary incontinence; bilateral radicular pain; and the subjects with lumbar spinal stenosis without any trigger points. During 48 hours before surgery, patients were examined by a physiotherapist. Demographic information of the patients was collected. Then, pain, disability, pain pressure threshold and the muscles with active trigger points have been recorded. In addition, pain intensity were measured by visual analogue scale (VAS), disability by oswestry disability index (Persian version) and pain pressure threshold using pressure algometer [18]. The patients were re-examined for mentioned outcomes three months after laminectomy.

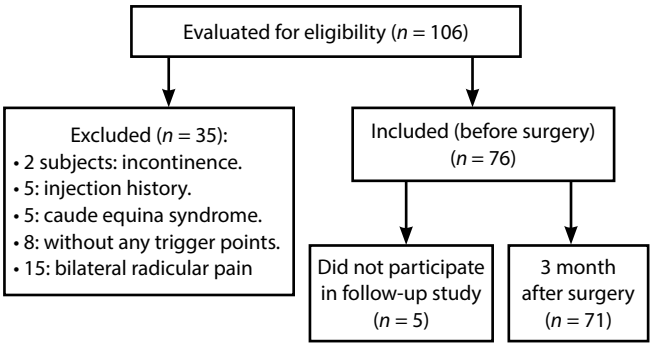

Fig. 1. *Participant flow chart*

Pain intensity were determined using the VAS. The patient was asked to indicate the pain intensity on a 100 mm line. The number zero indicates the absence of pain and the number 100 indicates the maximum amount of pain that the subject had experienced. Validity and reliability of visual pain measurement criteria have been proven in previous studies [19, 20].

The oswestry disability index was used to assess the degree of disability of patients with low back pain. This questionnaire includes 10 sections. Each section contains 6 questions and has 5 points. The first question is given a score of zero and the last question is given a score of 5. The patient was asked to answer questions according to his/her daily activities. The final score is calculated as a percentage of disability. The validity and reliability of the Persian version of this scale has been proven in previous studies [18].

Pressure algometer (SF model, South Korea) were used to quantify the pressure threshold of pain before and after treatment on trigger points. The device consists of a gun-shaped handle with a pressure-sensitive disk measuring one square centimeter at the tip [21]. to make the patient more familiar with this device, the examiner will show it on the styloid process of the right ulnar bone. The pressure gauge was placed on the trigger points and was measured 3 times. The average of 3 measurements was recorded as the amount of pressure pain threshold in kilograms per square centimeter. It should be noted that the amount of pressure applied by the examiner was constant at an approximate speed of one kilogram per second. Patients were asked to say "yes" to the onset of pain as soon as the pressure changes. The mean values of trigger points in the muscles was recorded before and after laminectomy [21, 22].

Trigger points were found by palpating lumbar and lower limb muscles. Palpation (direct finger pressure, flat and pinch) was performed by an experienced physiotherapist [23]. In this study, muscles of lumbosacral and lower limb which have been evaluated were as follows: multifidus, quadratus lumborum, longissimus thoracis, iliocostalis lumborum, piriformis, gluteus maximus, gluteus medius, gluteus minimus, tensor fasciae latae, biceps femoris, semitendinosus and semimembranosus, medial and lateral gastrocnemius, soleus and tibialis anterior [23]. The exact primary points of myofascial pain syndrome in these muscles have been shown in figure 2 [23, 24]. Palpable taut band, tenderness and pain recognition were three main criteria for diagnosing trigger points [16]. The number of muscles with trigger points, the number of active trigger points in each patient were recorded.

STATISTICAL ANALYSIS

Statistical Package for the Social Sciences software (SPSS for Windows, Version 23.0) were used to analysis data. Frequency and descriptive analysis were performed to check all relevant characteristics of the patients. Results are showed as percentages (%), mean and/or standard deviation (SD). Also, the Shapiro–Wilks test was used

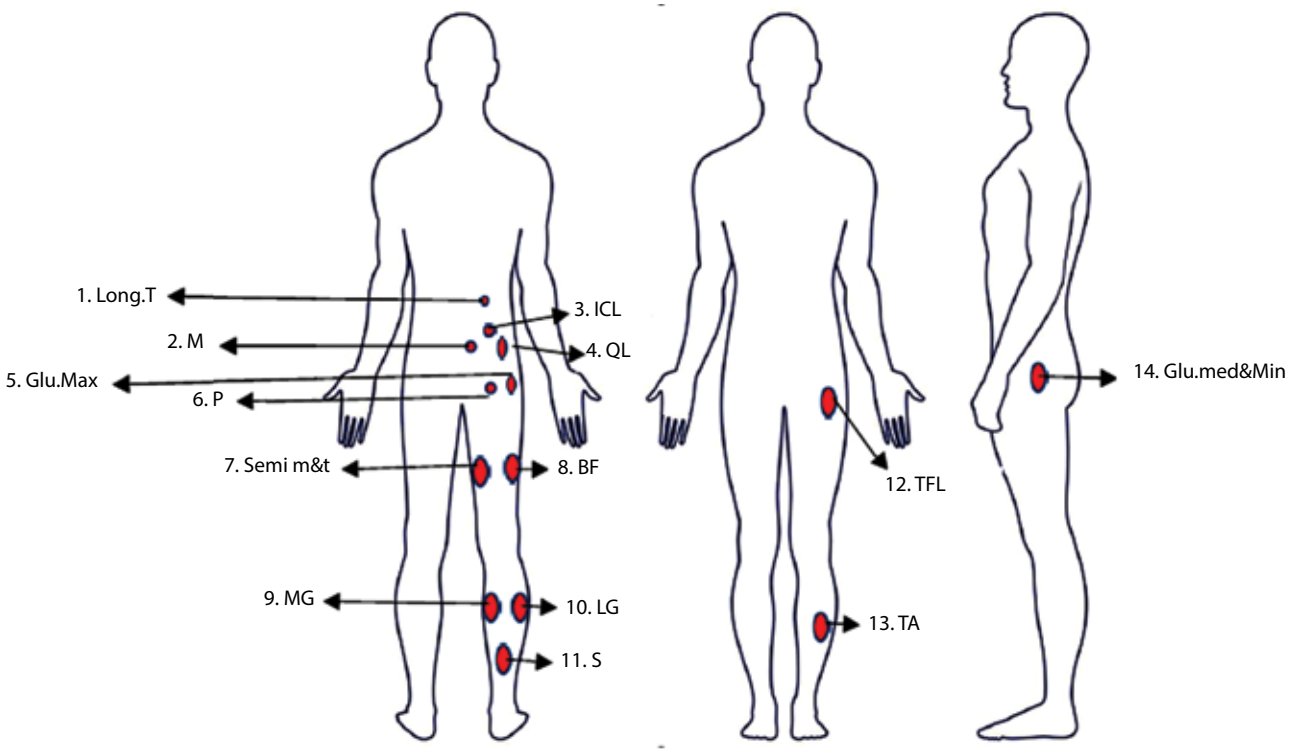

Fig. 2. *The sites of active trigger points in 15 muscles of lumbar and lower limb in patients with chronic low back pain before and after lumbar laminectomy: 1. Long.T – longissimus thoracis, 2. M – multifidus, 3. ICL – iliocostalis lumborum, 4. QL – quadratus lumborum, 5. Glu.Max – gluteus maximus, 6. P – piriformis, 7. Semi m&t – semimembranosus and semitendinosus, 8. BF – biceps femoris, 9. MG – medial gastrocnemius, 10. LG – lateral gastrocnemius, 11. S – soleus, 12. TFL – tensor fasciae latae, 13. TA – tibialis anterior, 14. Glu.med&Min – gluteus medius, gluteus minimus*

to assess the normal distribution of the data. Paired t-test and Chi-square were used to compare variables before and after intervention. Differences in the number of active trigger points pre and post surgery were analyzed with the Chi-square (χ^2) test. A P value less than 0.05 were considered statistically significant.

RESULTS

From 106 subjects, a total of 71 individuals were included in the study. 35 subjects were excluded from the study, n = 8 subjects because they did not show trigger points during first evaluation, n = 5 subjects because they presented the symptoms of cauda equine syndrome, n = 2 subject due to incontinence, n = 5 because of injection history and n =15 patient with bilateral pain. As well, 5 subjects did not participate in the follow up assessment (figure 1). 59.2 % (n = 42) of participants were female and 40.8 % (n = 29) were male. Findings related to the descriptive statistics are provided in table 1.

According to the results, 5, 8 and 9 muscles were involved in 12.7 % of subjects (n = 9). The majority of the patients (23 cases, 32.4 %) revealed 3 active trigger points of the muscles before surgery. 60 subjects (84.5 %) experienced a gradual onset of leg pain without a trauma history.

Lumabr multifidus (74.9 %), medial gastrocnemius (73.2 %), soleus (70.4 %) gluteus medius (62 %) were the most involved muscles with trigger points before laminectomy.

Table 1. *Demographic characteristics of the patients with low back pain before laminectomy*

	Minimum	Maximum	Mean ± SD
Age, years	23	60	48 ± 13.41
Weight, kg	47	91	72.51 ± 8.92
Height, cm	155	182	169.24 ± 6.14
BMI, kg/m^2	19.12	29.14	25.92 ± 2.01
Pain duration, m	3	48	6.78 ± 12.17

Abbreviations: *SD – standard deviation; kg – kilogram; cm – centimeter; m^2 – squared meter; BMI – body mass index; m – month.*

On the other hand, After laminectomy medial gastrocnemius (54.9 %), lateral gastrocnemius (53.5 %), soleus (50.7 %), multifidus (39.4 %) and quadratus lumborum (39.4 %) were the most involved muscles with trigger points. The exact amount of all muscle's prevalence is represented on Table 2.

Table 2 indicate that the existence of trigger points in longissimus thoracis (p = 0.04), quadratus lumborum (p = 0.001), gluteus maximus (p = 0.04) and tibialis anterior (p = 0.02) were decreased significantly after laminectomy. Also, these findings show that the existence of trigger points in all muscles were decreased after

Table 2. *The frequency and percentage of muscular involvement in patients with disc herniation before and after laminectomy*

	Muscle	Frequency of active trigger points, *n*		Percentage of active trigger points, %		Chi-square	*P* value
		before (*n* = 71)	after (*n* = 61)	before	after		
1	Multifidus	54	28	**74.9**	**39.4**	0.75	0.38
2	Longissimus thoracis	22	15	31	21.1	4.20	**0.04**
3	Iliocostalis lumborum	24	11	33.8	15.5	0.01	0.91
4	Quadratus lumborum	38	28	53.5	**39.4**	11.44	**0.001**
5	Gluteus maximus	23	10	33.4	14.1	0.41	**0.04**
6	Gluteus medius	44	19	**62**	26.8	2.45	0.11
7	Gluteus minimus	18	6	25.4	8.5	2.75	0.09
8	Piriformis	30	24	42.3	23.8	2.15	0.14
9	Tensor fasciae latae	12	8	16.9	11.3	0.30	0.58
10	Semitendinosus and semimembranosus	37	25	52.1	25.2	0.96	0.32
11	Biceps femoris	31	25	43.7	35.2	0.004	0.95
12	Medial gastrocnemius	52	39	**73.2**	**54.9**	0.55	0.45
13	Lateral gastrocnemius	39	38	54.9	**53.5**	0.36	0.54
14	Soleus	50	36	**70.4**	**50.7**	0.31	0.57
15	Tibialis anterior	21	10	29.6	14.1	5.34	**0.02**

surgery but most of them are not significant before and after surgery ($p > 0.05$).

Table 3 shows the mean changes of quantitative variables before and after laminectomy. Pain, disability and PPT revealed significant differences before and after surgery.

Table 3. *The comparison of pain, disability and pressure pain threshold before and after laminectomy*

Variable	Time	Mean ± SD	*P* value
Pain (VAS)	Before surgery	8.32 ± 1.79	**0 < 0.001**
	After surgery	3.35 ± 2.42	
Disability (Oswestry)	Before surgery	30.21 ± 6.35	**0 < 0.001**
	After surgery	20.5 ± 6.25	
Pressure pain threshold (algometer)	Before surgery	10.37 ± 1.5	**0 < 0.001**
	After surgery	11.5 ± 1.67	

Abbreviations: VAS – visual analogue scale.

DISCUSSION

The findings of the present study showed that pain, disability and pain pressure threshold have been improved after laminectomy. These results were in agreement with the findings of other studies [3, 25–29]. To the best of our knowledge, the present study is the first one investigating myofascial origin of spinal pain to legs in patients suffering from disc herniation of the L4 and L5 after laminectomy. The results showed that lumbar laminectomy did not increase trigger points in trunk and lower limb muscles. In contrast, it reduces them and even in proximal muscles, there would be less trigger points.

Trigger points are main characteristics of myofascial pain syndrome and can result from long time muscle contraction, overloading, or performance of repetitive movements [6]. In spite of the evaluation and treatment of trigger points in different classifications of spinal pain, some literature mentioned that surgery may cause trigger points [7, 14]. Like our recent study, the present study revealed that many people suffering from chronic low back pain may show the symptoms of myofascial pain syndrome at least in four or five groups of the trunk and lower limb muscles [24]. In more than 50 % of the patients, myofascial pain was observed in multifidus, medial gastrocnemius, soleus, gluteus medius, lateral gastrocnemius, quadratus lumborum, and medial hamstring before surgery. However, more than 50 % of patients showed symptoms only in lateral gastrocnemius, medial gastrocnemius, and soleus after surgery. Before and after surgery, multifidus and medial gastrocnemius showed highest level of involvement respectively. Previous studies have shown a high prevalence of active trigger points in the multifidus muscle in patients with chronic nonspecific low back pain [24]. In this study, multifidus was

the most involved muscle before surgery. Multifidus muscle plays a very critical role in stability and mobility of the back, so that two thirds of the stability of the back is provided by this muscle. The dual function of this muscle is the reason for the high prevalence of trigger points in it [30, 31]. Although the prevalence of trigger points decreased after laminectomy, it is still one of the muscles that showed a high percentage of involvement and should be considered after laminectomy. On the other hand, gastrocnemius muscles also showed a higher incidence of active trigger points after laminectomy. It confirms the report of pain in the posterior legs and soles in these patients after surgery. Immobility, medication, positioning after surgery and lack of daily stretching may be the most common causes of trigger points of these muscles after surgery [16, 32].

The longissimus thoracis, quadratus lumborum, gluteus maximus, and tibialis anterior muscles showed significant reduction of trigger points compared to before surgery examination; whereas no significant reduction of involvement was observed in other muscles. The evidence from the present study suggests that lumbar laminectomy may reduce myofascial pain in proximal muscles and those muscles innervated by L5 nerve root. This is not in agreement with those studies suggesting that surgery can create trigger points due to damaging soft tissues surrounding the low back [33]. Central sensitization in subjects with active trigger points is considered as a neurological factor in the creation and continuation of pain [34]. Central sensitization is defined as increase responsiveness of receptors to stimulations which may cause pain hyper sensitivity [33].Therefore, nerve root decompression associated with muscles may be able to reduce central sensitivity and thus reduce pain and release trigger points [35]. In the present study, the improvement of pain pressure threshold after laminectomy is one the confirming factors for this hypothesis. Therefore, in tibialis anterior muscles significant reduction of active trigger points were observed. It is also important to note that since the trigger points are neurally mediated, the modification and release of nerve roots following laminectomy may be effective in reducing patients' pain [33].

The time elapsed from surgery may also be considered as a factor in the development and prevalence of active trigger points. Fernandez-Lao et al revealed that although the time of muscle evaluation after surgery was different between the two groups, but no significant difference in the number and prevalence of trigger points was observed between the two groups [17]. In the present study, at least three months had elapsed since the laminectomy in the second evaluation. However, it seems that in the acute phase after surgery, the probability of eliciting active trigger points is higher [33].

The present study showed several limitations. Firstly, we only investigated long-term follow ups for patients. Immediate results of laminectomy on outcomes were not evaluated. Secondly, because of the selecting patients for surgery, it was not possible to design a control group for the study. Thirdly, Palpation (based on three main criteria) was the only method to diagnose the trigger points in muscles. Fourthly, the psychosocial status of the patients was not recorded in the current study. Fifthly, although data was collected in a single hospital, lumbar disc surgeries were performed by two surgeons.

CONCLUSION

The present study revealed that pain, disability, number and prevalence of trigger points decreased after lumbar laminectomy. Nevertheless, pressure pain threshold of trigger points increased after surgery. The pattern of active trigger points of muscles was different before and after surgery. Multifidus and gastrocnemius were the most prevalent muscles with myofascial pain syndrome before and after surgery respectively. In fact, current results showed that active trigger points should be considered before and after laminectomy surgery.

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COMMENT ON THE ARTICLE "THE EFFECTS OF LAMINECTOMY SURGERY ON PAIN, FUNCTIONAL DISABILITY, SENSITIZATION AND ACTIVE TRIGGER POINTS IN SUBJECTS WITH LUMBAR DISC HERNIATION"

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The article is devoted to study the course of myofascial syndrome in patients with the development of degenerative stenosis of lumbar spine at the level of L4–L5. The development of degenerative changes (stenosis of the spinal canal) often forms direct or reflected musculoskeletal pain syndromes (in everyday life myofascial syndrome), negatively affecting surrounding tissues (including the muscles), causing a damage of their innervation and blood supply, which leads to spasms, pain, forced posture, which in turn worsens muscle condition and metabolism. The developed vicious circle can be broken only with a complex effect on all steps of pathogenesis of myofascial syndrome, in particular to the area of origin (Pilipovich A.A., Danilov A.B. Myofascial pain syndrome: from pathogenesis to treatment. Russian Medical Journal. Pain syndrome 2012; 0 (special issue): 29–32) or to trigger points located in the zone of dermatomes innervations (direct or reflected).

Trigger points can form anywhere in skeletal muscles, which means that any muscle may be affected by trigger points. According to our observations, if there are some trigger points in few muscles, then they are not clinically significant or quickly disappear on their own, even in the absence of treatment. However, triggers tend to «spread», that is, over time, with the advent of the first triggers, the more and more threads begin to appear in previously unaffected muscles. As a rule, pain and anxiety arise when there are many triggers – dozens of trigger points.

The trigger points is a specific symptom typical for myofascial syndrome only. They fundamentally differ myofascial syndrome from all other variants of pain syndrome (in particular, the radicular pain).

The authors of the article conducted a study of the dynamics myofascial pain syndrome changing as a result of surgical treatment of stenosis in the form laminectomy. The volume of the laminectomy remains a question – perhaps there was either the resection of the arches without facetectomy performed or the medial resection of the facet joints to prevent instability. In any case, the authors note a significant decrease in the pain syndrome intensity (according to the visual analog scale of pain) and signs of social maladaptation (according to the Oswestry scale) as a result of surgical interventions. At the same time, high reactivity of the patients remains in terms of reproducing pain syndrome when exposing the trigger points by the original method of mechanical algometry, which makes it possible to digitally evaluate the safety of the trigger mechanism trigger zones in myofascial syndromes.

Thus, as the most active points of manifestation of myofascial syndrome, the zones in the areas of attachment of *m. Multifidus* like most actively involved in maintaining mobility and stability of the spine, and *m. Gastrocnemius*, which has, perhaps, the maximum number of trigger points in areas of connection with tendons.

This article demonstrates importance of understanding of continuity between the assessment of the features of pain syndromes that are sometimes not amenable to topical interpretation (like the myofascial syndrome), and options for surgical decompression, that are so often and uncontrollably used in the treatment of degenerative lesions of the spine.

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