Original article

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The problem of adipose degeneration of the paraspinal muscles in patients after surgery for degenerative stenosis

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Abstract

Degeneration of the multifidus muscle of the back after stabilizing operations on the lumbar spine and its impact on rehabilitation measures remains understudied. There are isolated data in publications on the partial effectiveness of minimally invasive surgery, but the problem has not been completely solved, there is no data on the effect of physical therapy and physiotherapy methods on the progress of degeneration of the multifidus muscle of the back. **Purpose** To study the effect of electroneuromyostimulation and physical therapy in the postoperative period in decompression-stabilizing operations on the progress of adipose degeneration of the multifidus muscle of the back. **Materials and methods** The parameters of the multifidus muscle of the back were analyzed and determined in 3 groups of patients who underwent operations with stabilizing systems in the lumbar spine: in group I (n = 56), it was recommended to limit physical activity for 2 months after surgery and wear a semi-rigid corset; in group II (n = 41), early rehabilitation was initiated in the form of physical therapy with the continuation of the recommended exercises after discharge, in group III (n = 43), patients after discharge were recommended to limit physical activity, but with the use of electroneuromyostimulation on the paravertebral muscles 2 times a day lasting 15–30 minutes. All patients underwent clinical examination, MRI, MSCT to assess the condition of the multifidus muscle. **Results** In group II, there was a decrease in the rate of adipose degeneration of the multifidus muscle, but with increase in pain and decrease in life quality compared to group I. Patients of group III had the lowest rate of increase in adipose degeneration with less pain and a higher level of life quality compared to groups II and I. **Conclusions** A combination of early postoperative stimulation for two months with a subsequent transition to physical therapy is optimal; otherwise exceeding the functional threshold may cause disruption of adaptation systems.

Keywords: fatty degeneration, paraspinal muscles, multifidus muscle of the back, stabilizing system

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INTRODUCTION

Application of decompression and stabilization operations for degenerative stenosis became an integral part of current spinal surgery. The use of dorsal approaches leads to inevitable injury of the paraspinal muscles, in particular, the multifidus dorsi, that is involved in providing stability [1–6]. No matter how small is an access, it causes swelling and fat degeneration of the paraspinal muscles [7, 8]. Application of minimally invasive techniques of screw placement and decompression, regardless of the positive results, does not completely solve the problem [9–11], that is confirmed by the results of magnetic resonance imaging in dynamics and data on the quality of life of the patients [12, 13]. In addition, a number of studies

indicate damage of the innervation of the paraspinal muscles during access and the absence of cross innervation, that also plays a significant role in fatty degeneration of the latter [14, 15]. Current literature, does not provide enough information on the effect of electrical neuromyostimulation on the degeneration of the multifidus muscle of the spine in the postoperative period, therefore, the study of this problem is relevant.

Purpose of the study: to study the effect of electrical neuromyostimulation and exercise therapy in the postoperative period in decompression and stabilization operations for degenerative stenosis on the progression of fatty degeneration of the multifidus muscles of the spine.

MATERIALS AND METHODS

The study included 140 patients with degenerative stenosis in lumbar spine aged from 27 to 64 years. All patients signed informed consent for their examination and inclusion of their data in the research work. All subjects underwent posterior spinal fusion for symptomatic degenerative stenosis and instability of L4–L5–S1 of the lumbar spine in the period from 2016

through 2017. The length of ineffective conservative therapy before surgery was not less than 4 weeks. The follow-up period after surgery was at least 2 years. The study included patients with achieved canal decompression and without malposition of pedicle screws according to MSCT data. Depending on the character of postoperative care, 3 groups of patients

were defined: in group I (n = 56), it was recommended to limit physical activity within 2 months after surgery and wear a semi-rigid corset; in group II (n = 41) early rehabilitation including exercise therapy followed by recommended exercises after discharge was performed; in group III (n = 43) the patients after discharge were recommended to limit physical activity, but with the application of electrical neuromyostimulation in the area of paravertebral muscles twice a day during 15-30 minutes.

The VAS (Visual Analogue Scale) and Oswestry scale were assessed before the operation, on the 7th day after the operation, in 3, 12 and 24 months after the operation. To assess the condition of patients with spinal stenosis, the Swiss Spinal Stenosis Questionnaire (SSS) was used and studies were conducted in 1 month after the patient's discharge. Patients underwent MRI of the lumbar spine before surgery, in 3 and 12 months after surgery. MSCT of the lumbar spine was performed on the 7th day after the operation for control check-up before discharge.

RESULTS

The analysis of complaints, clinical picture and rating scale data showed the groups' homogeneity of examined patients. The dynamics of indices according to the VAS and the Oswestry scales in the early postoperative period corresponded to the volume and type of surgical intervention and had no static differences from the data of other authors [20–23].

The length of in-patient stay after operation was mean 5.8 ± 0.9 days. Patients were made active on the 1st day after the operation. At the time of discharge, there was a significant improvement in the quality of life and regression of the pain syndrome, which preserved in the late follow-up of 3, 12, and 24 months but the dynamics was different depending on the type of postoperative care (Tables 1 and 2).

The data in the Table show that the exercises prescribed in the early period caused pain increase,

The severity of fat degeneration of the multifidus muscle was assessed by the ratio of the area in the axial projection at the level of the upper endplates of L3, L4, L5, S1 to the average density value according to the Hounsfield scale. According to MSCT data, the average values for fat were 84 HU, the same for muscles was +40 HU. For MRI processing, we used the Pixel Intensity index. The following formula was used to restore the Hounsfield value for this pixel: $HU = \text{Pixel Intensity} \cdot \text{Rescale Slope} + \text{Rescale Intercept}$. The Rescale Intercept and Rescale Slope parameters depended on the device that was used to take the images and were located in the metadata of the set at the addresses (0028.1052) and (0028.1053) respectively [16–19]. RadiAnt DICOM Viewer 4.2.1 software was used to define the area and average density of the multifidus muscle in DICOM images. Statistical processing was performed using the Statistica 9.0 package. For cross-sectional comparison, the Mann–Whitney and Wilcoxon nonparametric statistics tests were used and for binomial features, Pearson's chi-square (χ^2) was used. The results obtained are presented by median and quartiles.

while physical activity restrictions reduced the intensity of pain and the late follow-up in both tactics caused poor assessment of the quality of life of patients in the period from 12 to 24 months. Using electrical neuromyostimulation, the patient stimulated only the paravertebral muscles, without general weightbearing on the body and did not put a load on the fixation system. The intensity of pain in the late follow-up in group III was 2 points lower than in group I, and 1.5 points lower than in group II according to VAS. Quality of life according to the Oswestry scale in the late follow-up in group III was 9.2 % higher than in group I and 11.2 % higher than in group II, that was caused by the absence of a destabilizing effect of physical activity on the implanted structure, and, at the same time, by stimulation of the muscle tissue that slowed down or delayed the processes of fat degeneration.

Table 1

The dynamics of indices of pain syndrome severity according to the VAS scale

Groups	VAS, scale			
	Before operation	3 months follow-up	12 months follow-up	24 months follow-up
I group (n = 56)	7.3 [5.4;8.1]	1.7 [5.4;8.1]	2.7 [5.4;8.1]	3.5 [5.4;8.1]
II group (n = 41)	6.9 [5.2;7.9]	2.8 [0.8;4.2]	3.1 [0.8;5.6]	3.0 [0.8;5]
III group (n = 43)	7 [4.4;7.5]	1.8 [0.1;3.2]	1.2 [0.1;1.6]	1.5 [0.1;1.8]

Table 2

Dynamics of indices of the level of quality of life according to the Oswestry scale 2.1a

Groups	Oswestry 2.1a, %			
	Before operation	3 months follow-up	12 months follow-up	24 months follow-up
I group (n = 56)	41.7 [35.4;68.1]	10.4 [4;12.1]	12.6 [4;18.7]	13.2 [5.4;17.1]
II group (n = 41)	45.2 [40;66.9]	13 [3.2;18.4]	16.6 [6.4;20.2]	15.2 [5.4;18.]
III group(n = 43)	44.3 [41.1;70.1]	6.2 [2;8]	4.2 [1;7.1]	4 [1;5.1]

In evaluation of mean Hounsfield values and area of the multifidus muscle at L3, L4, L5, S1, no significant differences in preoperative values were found. In patients of groups I and II, in follow-up from 3 to 24 months, an increase in fatty degeneration of the multifidus muscle at L4–L5–S1 and, to a lesser extent, at the level L3, is clearly observed. In group III, the intensity of fat

degeneration was significantly slower and did not differ statistically both at the levels L4–L5–S1 and at the level L3 (Table 3).

There were no statistical differences in the number and type of postoperative complications in all three groups, therefore, that could not be reflected in the results of the study.

Table 3

Dynamics of indices of the mean Hounsfield value and the area of the multifidus muscle

Groups	Level of measurements	mean Hounsfield value and the area of the multifidus muscle, HU			
		Before operation	Post-op check-up	12 months after operation	24 months after operation
I group (n = 56)	L3	12	12	6	-2
	L4	10	10	-15	-32
	L5	4	3	-28	-40
	S1	3	2	-40	-46
II group (n = 41)	L3	11	11	10	5
	L4	10	9	-5	-11
	L5	5	3	-23	-41
	S1	3	2	-32	-43
III group (n = 43)	L3	13	13	10	12
	L4	11	10	8	8
	L5	4	3	-10	-8
	S1	2	0	-20	-15

DISCUSSION

According to the results of the study, paraspinal muscles in the lower lumbar segments are more vulnerable to fatty degeneration what is witnessed by current literature data [24–27]. The studies are mainly focused on the choice of the technique of surgical intervention to reduce fatty degeneration, underlying the similarity in the tactics of managing patients in the postoperative period [28]. A number of researchers indicated the significant effect of increased body mass index in acceleration of degeneration not only of the affected disc, but also of the adjacent segment [29],

which was proven radiologically in the works of Zhu. Wang et al point out that multilevel interventions are the main factor affecting the rate of paraspinal muscle degeneration, while Anandjiwala et al [30] consider the initial level of muscle condition to be the key factor. In our study, we showed the effect of various rehabilitation options on the late outcome of treatment, that, definitely, is also affected by the initial state of the paraspinal muscles.

This work has no significant limitations that must be taken into account when interpreting its results.

CONCLUSIONS

The data obtained indicate the usefulness of physiotherapy procedures, i.e. electrical neuromyostimulation, in the early postoperative period.

It is wise to apply exercise therapy from the 2nd month of the postoperative period, when the wound process slows down and the postoperative pain

syndrome is eliminated. In addition, it reduces the load on the implanted structure in the acute period.

We think it is useful to combine early postoperative stimulation for two months followed by physiotherapy exercises, otherwise, exceeding the functional threshold may lead to a failure of adaptation systems.

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