Progressive resistance exercise in patients with pituitary adenoma: it does work

Type

Research paper

Keywords

fatigue, management, care, pituitary adenomas, progressive resistance exercise

Abstract

Introduction
It is necessary to investigate the effects of progressive resistance exercise (PRE) in patients with pituitary adenomas after surgery, to provide insights to the clinical management of pituitary adenomas.

Material and methods
This study is a pre- and post-control experimental study design with hypothesis that PRE can reduce the postoperative fatigue. Patients with pituitary adenoma were included. The control group received conventional postoperative rehabilitation guidance, and the PRE group received the PRE on the basis of routine rehabilitation. We measured the patient's muscle mass, muscle strength, vital capacity and postoperative fatigue level 1 day before and 12 weeks after the operation. SPSS 22.0 was used for data analysis.

Results
A total of 89 patients were enrolled, including 44 in the control group and 45 in the PRE group. There was no significant difference in muscle mass between the two groups in the 12th week after surgery, but the muscle loss of the left upper limb, trunk, and lower limbs of the control group was significantly higher than that of the PRE group (all $P<0.05$). The muscle strength and vital capacity of the control group were significantly lower than that of the intervention group, and the fatigue level was significantly higher than that of the PRE group(all $P<0.05$).

Conclusions
Progressive resistance exercise is helpful to combat muscle loss, muscle strength and lung function decline caused by long-term bed rest in patients with pituitary adenoma after operation, thereby improving the postoperative fatigue level of patients.

Title page

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Running title: progressive resistance exercise & pituitary adenoma

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Results: A total of 89 patients were enrolled, including 44 in the control group and 45 in the PRE group. There was no significant difference in muscle mass between the two groups in the 12th week after surgery, but the muscle loss of the left upper limb, trunk, and lower limbs of the control group was significantly higher than that of the PRE group (all $P<0.05$). The muscle strength and vital capacity of the control group were significantly lower than that of the intervention group, and the fatigue level was significantly higher than that of the PRE group(all $P<0.05$).

Conclusion: Progressive resistance exercise is helpful to combat muscle loss, muscle strength and lung function decline caused by long-term bed rest in patients with pituitary adenoma after operation, thereby improving the postoperative fatigue level of patients.

Keywords: pituitary adenomas; progressive resistance exercise; fatigue; care; management

Background

Pituitary adenomas (PA) are the most common sellar tumors[1]. Epidemiologic studies[2, 3] show that pituitary adenomas are increasing in incidence (between 3.9 and 7.4 cases per 100,000 per year) and prevalence (76 to 116 cases per 100,000 population) in the general population (approximately 1 case per 1000 of the general population). Although most of them are benign, they can cause headaches, loss of vision, infertility, acromegaly and other symptoms[4, 5]. Even after surgery, m any patients suffer from long-term discomfort symptoms, among which fatigue is the most common[6]. Fatigue will appear in patients after surgery and will persist for several months[7]. In some patients, sleepiness and fatigue will last for several years or even longer, which seriously affects the quality of life of patients and is not conducive to their return to the work and life[8, 9]. Postoperative fatigue (POF) is a common complication after major surgical operations. It refers to the decline in physical strength and energy of the patient after the operation, and the inability to complete the usual physical and mental work, which can last several weeks to several months after the operation[10-12]. The mechanism of POF is not completely clear. At present, it is generally believed that the production of POF is related to increased catabolism caused by surgical stress, insufficient postoperative nutritional intake, and decreased postoperative activities[13, 14]. One or more of the above factors lead to a decrease in body health and skeletal muscles and decreased cardiopulmonary function, so the patient feels weak and exhausted, unable to complete the job that should be competent[15]. Therefore, the management of POF is vital to the life quality of patients.

Although the minimally invasive transsphenoidal approach for pituitary adenomas has been widely used, in order to prevent cerebrospinal fluid rhinorrhea, patients still need to stay in bed for several

days after surgery, even if they can get out of bed about 5-7 days after surgery, their daily routine activities are still restricted[16, 17]. For example, it is forbidden to carry weight (over 20 pounds) or hold the breath forcefully, so as to avoid the increase of sphenoid sinus or intracranial pressure, causing cerebrospinal fluid rhinorrhea and retrograde infection. Therefore, patient's muscle loss and strength decrease and reduced cardiopulmonary function are caused by prolonged bed rest and limited mobility after the operation of the pituitary adenoma, so that after the end of the rehabilitation period, the patient feels particularly strenuous when engaging in normal preoperative activities again. This may be one of the reasons leading to POF. Based on the above assumptions, we instructed patients to perform low-intensity progressive resistance exercises(PRE) from the postoperative bedridden period until the end of the rehabilitation period (12 weeks after surgery), to verify the relationship between postoperative activity reduction and PA patients' POF, provide a basis for PA patients' POF intervention, thereby promoting postoperative recovery of PA patients and improving the quality of life of patients. We hypothesized that progressive resistance exercise is beneficial to improve the muscle loss, muscle strength, lung function and POF, thereby improving the quality of life in PA patients.

Methods

Ethical consideration

In this study, all methods were performed in accordance with the relevant guidelines and regulations. This present study had been verified and approved by the Medical ethics committee of the First Affiliated Hospital of Soochow University(approval number:2018179), and written informed consents had been obtained from all the included patients. Our study had been pre-registered in the China Clinical Trial Registry with Registration number:

ChiCTR2100047172(http://www.chictr.org.cn/showproj.aspx?proj=127529).

Sample size calculation

The sample size of this study calculated by the comparison formula of two groups[18]:

$n = \frac{\lambda}{2(\arcsin\sqrt{P_{max}} - \arcsin\sqrt{P_{min}})^2}$, we presume that $\alpha = 0.05$, $\beta = 0.2$, $\nu = 3-1 = 2$, then the $\lambda = 8.84$, set Pmax, Pmin, respectively, as the maximum and minimum incidence of postoperative fatigue (90.06% and 41.26%), then it comes to the results that n≈70. Meanwhile, considering the loss rate of about 10% of study population, that is, the patients included in each group should be at least 40 with a ratio of 1:1, and then at least 80 patients should be included.

Patients

We selected patients with pituitary adenoma who were treated in the Department of Neurosurgery of the First Affiliated Hospital of Soochow University from January 2019 to September 2020 as the research population. The inclusion criteria of patients were as following: (1) Preoperative disease was diagnosed as sellar area mass, sellar tumor or pituitary adenoma, and postoperative pathology report was pituitary adenoma; (2) The surgical method was lesions caused by transnasal sinus approach resection; (3) The age of the patient was18-65 years; (4) The patient had informed consent and voluntarily participated in the study and accepted follow-up. The exclusion criteria for patients were as following: (1) Those who had undergone surgery again within 12 weeks after surgery; (2) Those who had severe cardiopulmonary insufficiency and could not cooperate with exercise; (3) Disabled legs or knee joint and lumbar spine lesions could not tolerate muscle strength Those who measure; (4) Those who had metal grafts in their bodies that affect the accuracy of body composition measurement; (5) Those who disagreed to participant or required withdrawal during the research process.

Interventions

We included patients from January 2019 to August 2019 in the control group according to the order of hospitalization, and the outpatient follow-up ended in November 2019; patients admitted from December 2019 to September 2020 were included in the PRE group and followed up until December 2020.

The patients in the control group took the routine care intervention, including admission to 1 day before the operation, the patients completed preoperative examination and preparation, accepted nasal drops to clean the nasal cavity and shrunk the mucosal blood vessels, trimed the nose hair, practiced the cotton ball to plug the nose and breathe through the mouth. Patients were fasted for 8 hours before the operation and 4 hours of drinking. Patients accepted the postoperative ECG monitoring in bed, oxygen inhalation until the vital signs were stable. Most patients included in this study were ventilated for 24~36h after surgery to keep the body sign stable, we did not conduct PRE steps during the period of mechanical ventilation. We observed the bleeding of the nasal gauze 1-2 days after the operation, and removed the non-operative and operative nasal cavity packing successively 3-6 days after the operation. Postoperative pain assessment was carried out, the limbs were instructed to move on the bed, the lower limbs were massaged with a pressurized air pump, the circulation was promoted, the intake and output were recorded every day, and the blood electrolyte was monitored.

In the PRE group, patients in the intervention group added postoperative resistance exercise guidance on the basis of the routine care intervention. The exercise plan was formed on the basis of consulting relevant guidelines and expert consensus, and the final draft was revised after 2 rounds of expert letter inquiries. We mainly used low-intensity PRE and it is supplemented by aerobic

walking exercises after getting out of bed. The muscles of the upper limbs, lower extremities and trunk were all isotonic contraction exercises, which did not involve muscle isometric contraction exercises, and would not cause the patient to hold their breath and was much safter. The PRE intervention was divided into two parts: the bed rest period and the resistance exercise after getting out of bed. The former used a 1kg rice bag for resistance exercise, and the latter used Thera-Band elastic band for training. The colors of the elastic bands indicated different resistances. From low to high, they are brown, yellow, red, green, blue, etc., and the corresponding stretches were 1.1kg, 1.4kg, and 1.4kg when stretched to twice the original length (stretch rate 100%). 1.7kg, 2.1kg, 2.6kg, etc., before the operation, the patient should grasp the patient's hands to do chest expansion exercise and stretch 1 time length 20RM test to select the elastic band suitable for postoperative exercise. The specific PRE plans were presented in Table 1 and Table 2.

Table 1 Exercise plan for postoperative bed rest period

Table 2 Exercise plan after getting out of bed

Both groups of patients would receive a pituitary adenoma surgery rehabilitation manual during preoperative education. The content of the manual of the control group mainly involved the postoperative diet, posture and instructions. The rehabilitation manual of the PRE patient was added more contents about the PRE details. The rehabilitation exercise program and exercise diary were added on the basis for the patients to record after study and practice. We conducted telephone follow-ups at the 1st, 2nd, 4th, 7th week after discharge from the hospital and the 11th week after the operation. The follow-up of the patients in the control group mainly understood their recovery after discharge, including polydipsia, polyuria, and cerebrospinal fluid, and we reminded the medication

for symptoms such as rhinorrhea. In addition to the above follow-up content, patients in the PRE group would also be asked about their exercise status, whether they could complete the exercise according to the plan, whether the exercise was difficult, and whether there was any abnormality during the exercise. Meanwhile, they were reminded to continue exercising and recorded the exercise diary. In the last follow-up call, the patient would be reminded to follow up in time in the next week and completed the measurement of related indicators.

Outcome assessments

The main outcome indicator of this study was the patient's fatigue level, and the secondary outcome indicators were muscle mass, muscle strength and vital capacity. Among them, the level of fatigue was measured using the Multidimensional Fatigue lnventory(MFI-20), which was designed by Smets E of the University of Amsterdam School of Medicine in the Netherlands in 1993. It contains a total of 20 items and is divided into 5 dimensions. They are general fatigue, physical fatigue, mental fatigue, decreased vitality, and lack of motivation. Each dimension contains 4 items. The Likert 5-level scoring method is used to evaluate the degree of fatigue of the survey object within 24 hours. The higher the score, the greater the degree of fatigue. high. The Cronbach α coefficient of the Chinese version of the scale is 0.882[19], which has good reliability and validity.

The muscle mass was detected by a body composition analyzer (Inbody720Biospace Co., Japan), and the patient's body composition data is obtained through the bioimpedance measurement method, including the muscle mass of the upper limbs, lower limbs, and trunk.

Muscle strength included grip strength, leg strength, and back strength. Xiangshan EH101 grip strength meter (Zhongshan, Guangdong, China) was used to measure the grip strength of the patient's hands. Both the leg strength and the waist strength are measured by the BCS-400 electronic

back-force meter(Jiangsu Nantong Weighing Apparatus Factory, China). The leg strength was the extension strength of the knee muscles when standing and bending the knee at 115°-125°. The back strength was the strength of the back when the upper body was tilted forward 30° in a natural standing position. The above muscle strength was measured repeatedly 3 times, and the average value was taken.

Vital capacity was measured by an electronic spirometer (manufactured by Nantong Yuejian Physical Testing Equipment Co., Ltd., FMJ-10000). After turning on the power, we turned on the switch. After reaching the test state, we asked the patient to take a deep breath and exhale as quickly as possible against the mouthpiece, then we read the lung capacity at the end of the expiration, we measured 3 times and took the average value to record.

Statistical analysis

We used SPSS 22.0 to build a database, and two people checked and entered all the data. The continuous data conforming to the normal distribution were described by the mean ± standard deviation, and the independent sample t test was used to compare the differences between groups. The continuous data that did not conform to the normal distribution were described by the median, and the Mann-Whitney U test was used to compare the differences between groups. The count data were described by frequency and composition ratio, and the significance of the difference in frequency between groups was compared using the chi-square test. In this study, $P<0.05$ considered the difference between the groups to be statistically significant.

Results

The characteristics of included patients

A total of 100 patients were identified initially, there were 5 patients who were unable to follow up

192 in time for 12 weeks after the operation, and 6 patients were lost to follow-up due to transferred to
193 another area or hospital for treatment. Finally, a total of 89 patients were enrolled, including 44 in
194 the control group and 45 in the PRE group. As presented in Table 3, there were no significant
195 differences in the gender, place of residence, marital status, childbirth, education level, occupational
196 status, medical expenses payment method, tumor size, types of adenoma, mechanical ventilation,
197 duration of surgery, estimated blood loss during surgery between control and PRE group(all P>0.05),
198 indicating that the baseline data of the two groups of patients were relatively comparable.

199 Table 3 The general demographic data comparisons between control and PRE group

200

201 Body and muscle weight changes

202 As presented in Table 4, there was no significant difference in body weight and muscle weight of
203 upper limbs, lower limbs, and trunk between the two groups before surgery and at the 12th week
204 after surgery, but the postoperative muscle loss in the control group was significantly greater than
205 that in the PRE group (all<0.05).

206 Table 4 Comparison of body and muscle weight changes in patients with pituitary adenoma before
207 and after surgery (n=89)

208

209 Muscle strength and vital capacity changes

210 As shown in Table 5, there was no significant difference in muscle strength and vital capacity
211 between the two groups of PA patients before surgery (all P>0.05). At the 12th week after surgery,
212 the muscle strength and vital capacity of the intervention group were significantly higher than those
213 of the control group (all P<0.05).

Table 5 Comparison of muscle strength and vital capacity of patients with pituitary adenoma before and after surgery

Fatigue level

As shown in Table 6, there was no significant difference between the groups of patients with pituitary adenoma in each dimension of fatigue before surgery (all $P>0.05$). At the 12th week after surgery, the fatigue scores of each dimension of the control group were higher than those of the PRE group, and the difference was significant (all $P<0.05$).

Table 6 The fatigue level of patients with pituitary adenoma before and three months after surgery

Discussion

It is well known that patients who stay in bed for a long time will experience muscle loss[20]. It is reported that healthy people who stay in bed for 20 days will reduce the muscles of their lower limbs by 7-10%[21]. In this study, patients in the control group can get out of bed during the postoperative recovery period. However, based on the recommendations of “prevent colds, avoid hard coughs and sneezes; keep the stool unobstructed, avoid exerting breath to prevent cerebrospinal fluid leakage” in the discharge education, most of the patients are in the situation of “do not move without moving” and “do not dare to move casually” after being discharged from the hospital. So the muscles also appear similar to "disuse atrophy" changes[22, 23]. For safety reasons, the exercise program intensity of the intervention group is relatively low. According to reports[24, 25], medium to high-intensity resistance exercises have muscle-building effects. Therefore, although patients in the PRE group cooperated with the exercise program, they did not see a significant increase in muscle mass,

so that at the 12th week after the operation, there were only significant differences in the amount of changes in the left upper limb, trunk and lower limb muscles between the two groups of patients, and there was no significant difference in muscle weight between the groups. However, it can be seen from the difference in the amount of muscle change that even low-intensity resistance exercises have the effect of resisting postoperative muscle loss. There is no significant difference in the muscle changes of the right upper limbs of the two groups of patients, which may be related to the dominant hand on the right side of most people. Although the control group did not perform resistance exercises, the right hand would get more than the left hand in daily life behaviors, thus alleviating the consumption of the right upper limb muscles.

The state of being in bed with less movement after surgery can cause a decline in muscle function[26, 27]. Previous studies[7, 28, 29] have analyzed healthy volunteers who have been in bed for 7 days and found that their muscle function changes are very similar to those in postoperative patients. The exercise program of this study was designed to take into account the exercise of upper limbs, lower limbs, and lower back muscles. Strike walking, as a kind of aerobic exercise, has also been proven to effectively enhance the cardiopulmonary function[30-32]. Intervention is required at the 12th week after surgery in this study, the hand grip strength, low back strength, lower limb strength, and lung capacity of the patients in the group were significantly greater than those in the control group, indicating that the exercise program in this study can effectively delay the decline of muscle strength and lung function in patients with PA, while the body strength and lung function are also an important part of physical fitness affects the patient's exercise ability. It is speculated that the progressive exercise program of this study can alleviate the decline in motor function during the rehabilitation of patients after PA by combating the decline in overall muscle strength and

pulmonary function.

It has been reported that postoperative traumatic stress, reduced nutrient intake and long-term bed rest are important causes of POF[13, 33, 34]. For PA patients, the surgical method of transsphenoidal approach is far less traumatic than craniotomy. Therefore, the trauma-stress response is limited, the operation does not involve the digestive system, and the patient can eat as needed after waking up under general anesthesia[35]. The effect of nutritional limitation in POF is far less than that of major abdominal surgery. In order to avoid leakage of cerebrospinal fluid caused by increased intracranial pressure after surgery, patients usually need to stay in bed for 5-7 days, and their activities are still restricted after discharge[36, 37]. Decreased activity will cause the lack of stress stimulation of skeletal muscles, resulting in decreased muscle volume, reduced muscle strength and cardiopulmonary function, and patients feel extra exertion during normal activities, resulting in POF[38, 39]. Therefore, POF in PA patients should be mainly related to bed rest after surgery and the reduction of activities[40-42]. The results of this study also confirmed this hypothesis. There was no significant difference in the fatigue scores of the two groups of patients before the operation. At the 12th week after the operation, the fatigue scores of the intervention group were significantly lower than those of the control group. It may be explained that the progressive exercise partially offsets the postoperative muscle loss and the decline in motor function, so the patients in the PRE group are relatively less strenuous in performing some activities of daily living than the control group.

Several limitations in this present study must be considered, firstly, we chose 1 day before and 12 weeks after operation to measure the associated parameters, researchers usually observed more than 3 months to assess the muscle loss and fatigue especially for a rehabilitation study, the long-term

effects and safety of PRE program for PA needs further investigations. Secondly, we did not evaluate the life quality of patients, the indicators to evaluate the life quality of patients should be also indispensable to compare the effect of different intervention, further evaluations on the life quality of patients are needed in the future studies. Thirdly, limited by human and fund resources, it's difficult for us set the blinding on allocation, intervention and outcome assessment, which can lead to certain biases. Besides, the sample size is small in this present study, it is impossible to do stratified analysis based on factors such as age, tumor size et al. Therefore, more studies with rigorous design and larger sample size in different areas are needed to elucidate the role of PRE in the future.

Conclusions

The results of this study show that the PRE program for PA patients after surgery can partially offset the loss of muscles, muscle strength and lung function caused by bed rest and lack of movement, thereby effectively alleviating the level of POF. We hope that this result can be verified in more PA patients undergoing surgery, to provide new ideas for reducing POF and reliable evidence for the postoperative rehabilitation guidelines of PA treatment and nursing care.

List of abbreviations

PA: Pituitary adenomas

PRE: progressive resistance exercise

Declarations

Ethics approval and consent to participate

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Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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Author contributions

Meifen Shen, Li Wang designed research; Xin Zhao, Xueping Zhao, Danni Wang, Yanling Jiang, Fang Su conducted research; Meifen Shen, Li Wang analyzed data; Xin Zhao, Meifen Shen, Li Wang wrote the first draft of manuscript; Xin Zhao had primary responsibility for final content. All authors read and approved the final manuscript.

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Table 1 Exercise plan for postoperative bed rest period

Timepoint	Exercise	Frequency
1-2 days after surgery	① Half-recumbent short lever Asuka (no resistance)	10 times/group*2 groups, rest for 2 minutes between groups, once in the morning and once in the evening
3-4 days after surgery	② Plantar flexion, dorsiflexion of the foot ③ Half-recumbent anti-flood (1kg rice bag)	③④5-10 times/group*2 groups, ⑤5 times/group*2 groups. Rest for 2 minutes between each group, once in the morning and once in the evening
5 days after surgery to get out of bed	④ Quadriceps exercise ⑤ Hip bridge movement	③④10-15 times/group*2 groups, ⑤5-10 times/group*2 groups. Rest for 2 minutes between each group, once in the morning and once in the evening

Table 2 Exercise plan after getting out of bed

Timepoint	Exercise	Frequency
After getting out of bed to 1 month after surgery	⑥ Chest and back muscles exercises ⑦ Lumbar and abdominal muscles exercises ⑧ Upper arm muscles exercises ⑨ Lower limb muscles exercises (⑥-⑨ are elastic band resistance exercises)	⑥⑧ and ⑦⑨ exercise every other day, starting with 5 times/group*2 groups, gradually increasing to 10-15 times /group*2 groups, rest between each group for 2 minutes, practice each exeicise3 times/week. ⑩40-60 steps/minute, 10 minutes/day.
1-2 months after surgery	⑩Walking/Strive Walking	⑥⑧ and ⑦⑨ interval training, each item is gradually increased to 15-20 times/group*2 groups, each group rests for 2 minutes, each item is practiced 3 times/week. 60-90 steps/minute, 20 minutes/day
2-3 months after surgery		⑥⑧ and ⑦⑨ interval practice, gradually increase to 20-25 times/group*2 groups, rest 2 minutes between each group, each excise 3 times/week. 90-120 steps/minute, 30 minutes/day

Table 3 The general demographic data comparisons between control and PRE group

		Control group(n=44)	PRE group(n=45)	χ^2	P
Gender	Male	14	23	3.41	0.07
	Female	30	22		
Place of residence	City	32	35	4.91	0.09
	County	9	3		
	Rural area	3	7		
Marital status	Married	41	42	1.00	0.65
	Unmarried	3	3		
Childbirth	Yes	38	41	0.52	0.36
	No	6	4		
Education level	Primary school	8	5	4.46	0.22
	Junior high school	15	17		
	Senior middle school	15	10		
	University	6	13		
Occupational status	Employed	20	18	0.27	0.60
	Unemployed	24	27		
Medical expenses payment method	Self-paid	0	2	0.49	0.25
	Medical insurance	44	43		
Tumor size	Microadenoma	4	4	0.24	0.89
	Large adenoma	37	39		
	Giant adenoma	3	2		
Types of adenoma	Nonfunctional	30	29	0.14	0.71
	Functional	14	16		
Symptoms before surgery	Yes	38	42	0.32	0.23

	No	6	3		
Mechanical ventilation	Yes	40	41	1.66	0.19
	No	4	4		
Duration of surgery(min)		149.12±31.06	151.88±28.06	18.32	0.27
Estimated blood loss during surgery(ml)		308.85±50.23	291.42±45.62	22.71	0.13

Table 4 Comparison of body and muscle weight and changes in patients with pituitary adenoma before and after surgery (n=89)

		Group	Median	Average rank	Z	P
Body weight	Before surgery	Control group	65.55	45.94	-0.34	0.73
		PRE group	65.30	44.08		
	After surgery	Control group	65.60	44.00	-0.36	0.72
		PRE group	68.20	45.98		
	Change	Control group	0.95	41.90	-1.12	0.26
		PRE group	0.90	48.03		
Skeletal muscle weight	Before surgery	Control group	25.75	41.89	-1.12	0.26
		PRE group	26.80	48.04		
	After surgery	Control group	23.40	39.98	-1.81	0.07
		PRE group	27.00	49.91		
	Change	Control group	-1.30	38.65	-2.30	0.02
		PRE group	-0.60	51.21		
Left upper limb muscle weight	Before surgery	Control group	2.50	43.68	-0.48	0.63
		PRE group	2.48	46.29		
	After surgery	Control group	2.21	41.42	-1.29	0.20
		PRE group	2.51	48.50		
	Change	Control group	-0.16	39.33	-2.05	0.04
		PRE group	-0.05	50.54		
Right upper limb muscle weight	Before surgery	Control group	2.49	42.16	-1.03	0.31
		PRE group	2.61	47.78		
	After surgery	Control group	2.23	40.57	-1.60	0.11
		PRE group	2.52	49.33		
	Change	Control group	-0.12	39.69	-1.92	0.06
		PRE group	-0.04	50.19		

Trunk muscle weight	Before surgery	Control group	21.05	43.24	-0.64	0.53
		PRE group	22.00	46.72		
	After surgery	Control group	19.45	41.08	-1.42	0.16
		PRE group	21.60	48.83		
	Change	Control group	-1.00	37.81	-2.60	0.01
		PRE group	-0.30	52.03		
Muscle weight of lower extremities	Before surgery	Control group	13.65	41.61	-1.12	0.22
		PRE group	15.34	48.31		
	After surgery	Control group	13.16	40.27	-1.71	0.09
		PRE group	15.45	49.62		
	Change	Control group	-0.40	37.91	-2.56	0.01
		PRE group	0.08	51.93		

Table 5 Comparison of muscle strength and vital capacity of patients with pituitary adenoma before and after surgery

		Group	Median	Average rank	Z	P
Left upper limb strength	Before surgery	Control group	27.55	41.94	-1.10	0.27
		PRE group	29.20	47.99		
	After surgery	Control group	25.40	37.01	-2.89	0.004
		PRE group	28.80	52.81		
Right upper limb strength	Before surgery	Control group	28.65	41.85	-1.14	0.26
		PRE group	30.50	48.08		
	After surgery	Control group	26.45	36.76	-2.98	0.003
		PRE group	32.70	53.06		
Back strength	Before surgery	Control group	59.00	44.08	-0.33	0.74
		PRE group	57.00	45.90		
	After surgery	Control group	46.00	35.10	-3.58	＜0.001
		PRE group	69.00	54.68		
Lower limb strength	Before surgery	Control group	71.50	41.94	-1.10	0.27
		PRE group	82.00	47.99		
	After surgery	Control group	60.50	34.16	-3.92	＜0.001
		PRE group	103.00	55.60		
Vital capacity	Before surgery	Control group	2660.00	42.62	-0.86	0.39
		PRE group	2660.00	47.32		
	After surgery	Control group	2412.50	38.42	-2.38	0.02
		PRE group	2695.00	51.43		

Table 6 The fatigue level of patients with pituitary adenoma before and three months after surgery

		Group	Median	Average rank	Z	P
Comprehensive fatigue level	Before surgery	Control group	10.00	48.19	-1.16	0.25
		PRE group	9.00	41.88		
	After surgery	Control group	11.00	58.00	-4.72	＜0.001
		PRE group	7.00	32.29		
Physical fatigue level	Before surgery	Control group	10.00	44.72	-0.10	0.92
		PRE group	11．00	45.28		
	After surgery	Control group	13.00	57.68	-4.63	＜0.001
		PRE group	10.00	32.60		
Reduced activity	Before surgery	Control group	9.50	41.68	-1.21	0.23
		PRE group	11.00	48.24		
	After surgery	Control group	13.50	56.77	-4.27	＜0.001
		PRE group	10.00	33.49		
Reduced motivation	Before surgery	Control group	7.00	45.51	-0.19	0.85
		PRE group	7.00	44.50		
	After surgery	Control group	8.00	56.44	-4.17	＜0.001
		PRE group	6.00	33.81		
Mental fatigue level	Before surgery	Control group	7.00	44.76	-0.09	0.93
		PRE group	7.00	45.23		
	After surgery	Control group	8.00	50.52	-2.01	0.04
		PRE group	6.00	39.60		