DOI 10.18019/1028-4427-2017-23-1-38-43

Results of total hip replacement in patients with femoral neck pseudarthrosis

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Purpose Develop a complex of treatment and diagnostic measures in order to improve the results of total hip replacement in patients with femoral neck pseudarthrosis. **Material and Methods** Treatment results of 102 patients with pseudarthrosis of the femoral neck in the age range between 20 and 83 years who underwent total hip replacement were studied. Rehabilitation treatment for peripheral neuropathies according to the developed method was used in 38 (37.3 %) patients. Massage and exercise therapy only were administered in 64 (62.7 %) patients. Clinical, radiographic, electroneuromyography and densitometry methods were used in the current study. **Results** Before the operation, peripheral neuropathies of different severity grades were revealed in the lower extremities of 81 % of patients. Osteopenia was revealed in 16 %, and osteoporosis in 84 %. Diagnostic criteria of the level and severity of the lesions in the lower extremities nerves before and after total hip replacement were developed in order to distinguish a group of patients at risk of neurological complications. **Conclusion** The method of rehabilitative treatment developed by us provided good functional results in 91.3 % of patients.

Keywords: pseudarthrosis, femoral neck, total hip replacement, neuropathy, electroneuromyography, densitometry

INTRODUCTION

Total hip replacement (THR) in patients with femoral neck pseudarthrosis, especially in elderly patients, has been currently used as a method of choice [1]. Lower limb function recovery depends not only on the movements of the operated joint but also on the expressiveness of pain and lower limbs length correlation [2]. During the surgery, correction of lower limb length discrepancy is performed by an acute manual traction. However, there is a risk of neuropathies if correction of limb length is more than 3 cm that are one of the causes of pain in the postoperative treatment [3]. Another cause of pain is presence of post-traumatic changes in the paraarticular soft tissues [4, 5]. According to several authors, the incidence of postoperative neuropathies is from 0.7 to 3.0 % [6, 7, 8]. Patients may complain of having pain not only in the operated limb but also in the intact one [9, 10]. They develop compensation mechanisms of walking at the expense of the lumbar spine that in future result in its degenerative changes, radiculopathies and tunnel ischemic neuropathies [11, 12]. All these factors may lead to the development of pain of various origins in the limb that was operated, and inability to fully load the limb [13].

MATERIALS AND METHODS

Treatment results of 102 patients in the age from 20 to 83 years with femoral neck pseudarthrosis that had THR between 2008 and 2012 at the Saratov Research Institute for Traumatology and Orthopaedics were analyzed. There were 53 (52 %) males and 49 (48 %) females. Among them, thirty seven (36.3 %) had previous operations due to femoral neck fractures. All these patients had a relative leg length discrepancy from two to 6 cm. Ninety one patients (89.2 %) used crutches before the THR, three (2.9 %) walked with a cane, and eight (7.8 %) were not able to walk. Pseudarthrosis was from eight months to 10 years old. Complex postoperative rehabilitation treatment according to the method that was developed by us with the use of an active multichannel electrostimulation of the lower limb muscles was performed in 38 (37.3 %) patients (group 1) from the total of 102 patients. The remaining 64 patients (62.7 % – group 2) received only massage and exercise therapy after the surgery.

The results were studied with clinical, radiographic, electroneuromyographic (ENMG), electromyographic (EMG) and densitometry methods. Assessment of clinical and functional results of THR was performed with the use of the Harris score scale (HSS) [14]. Functional results were rated as poor if the HSS was lower than 69 points, fair if it was 70 to 79, good if it was from 80 to

Reshetnikov A.N., Korshunova G.A., Goriakin M.V., Reshetnikov N.P., Kireev S.I., Levchenko K.K., Zaretskov A.V., Belonogov V.N., Adamovich G.A., Kireev S.N. Results of total hip replacement in patients with femoral neck pseudarthrosis. *Genij Ortopedii*. 2017. T. 23. No 1. pp. 38-43. DOI 10.18019/1028-4427-2017-23-1-38-43.

89, and excellent if it was 90 points and higher. Statistical processing was conducted on IBM PC «Intel®Core 2 Duo™» with the use of STATISTICA-6.0 (Statsoft@ Inc., USA), Microsoft Excel 2007, and Microsoft Access 2007 for Windows XP. Normality of distribution was checked with the Shapiro-Wilk test. The parametric Student's test was used for normal distribution of variation rows. A non-parametric method of sample study with the use of paired Wilxoson t-test was used for non-conformity to the law of normal distribution. Differences between the groups were considered statistically significant by $p \leq 0.05$.

RESULTS

Electrophysiological study of the lower limb peripheral nerves and muscles was conducted in 84 (82.4 %) patients. In 16 (19 %) of them, the initial findings corresponded to the age norm. In the remaining 68 (81 %) cases, a reduction in the values of the excitation conduction along the motor axons and in M-response amplitudes of the tibial and, especially, peronial nerves was revealed that frequently had a bilateral character. Mean values of the peronial nerve M-response did not exceed 2.9 ± 0.4 mV ($p < 0.05$) while the values of the tibial nerve M–response were lower on the side of the femoral neck pseudarthrosis and measured 3.0 ± 0.4 mV ($p < 0.05$). The values of M-response on the contralateral side corresponded to the low limit of the norm. Reduction in the initial ENMG values of the lower limb peripheral nerves in 41 patients (48.8 %) was bilateral despite the fact that the injury was unilateral. The values of M-responses were between 35 and 50 % from the age norm on the side of pseudarthrosis and contralateral limb.

The study of the conduction function of the nerve fibers at the level of the proximal sections by examination of afferent conductivity showed that an additional evoked potential (A–wave) between the M- and F-waves with a latent period of 19.7 ± 0.8 μsec that should be absent in the normal condition was recorded in 59 % of cases on the side of the fracture (**Fig. 1**).

The A–wave was recorded mostly in the patients that had a previous osteosynthesis of the femoral neck fracture. The appearance of such a potential we refer to the presence of a local collateral outgrowth of axons as a response to sciatic nerve trunks compression at the level of the femoral injury.

The analysis of the examination that was prior to THR revealed the reduction in bone mineral density (BMD) such as osteopenia in 16 % of patients and osteoporosis in 84 %. The materials for comparison were the findings available in the database of the densitometer. In order to define a grade of osteoporosis, the T-criterion was used that is the number of standard deviations higher and lower to the mean value of the bone mass peak (ratio of the actual BMD to the peak one).

Change in the BMD value was considered while planning the intervention and for selection of the implant size. In order to prevent implant instability and migration, the patients with low BMD values were recommended with an individual loading regime on the operated limb. Treatment of osteoporosis was performed at all stages of rehabilitation and allowed us to increase BMD in our patients on average by 3 % during a year and to avoid the complications due to osteoporosis such as periprosthetic fractures and aseptic instability (**Fig. 2**).

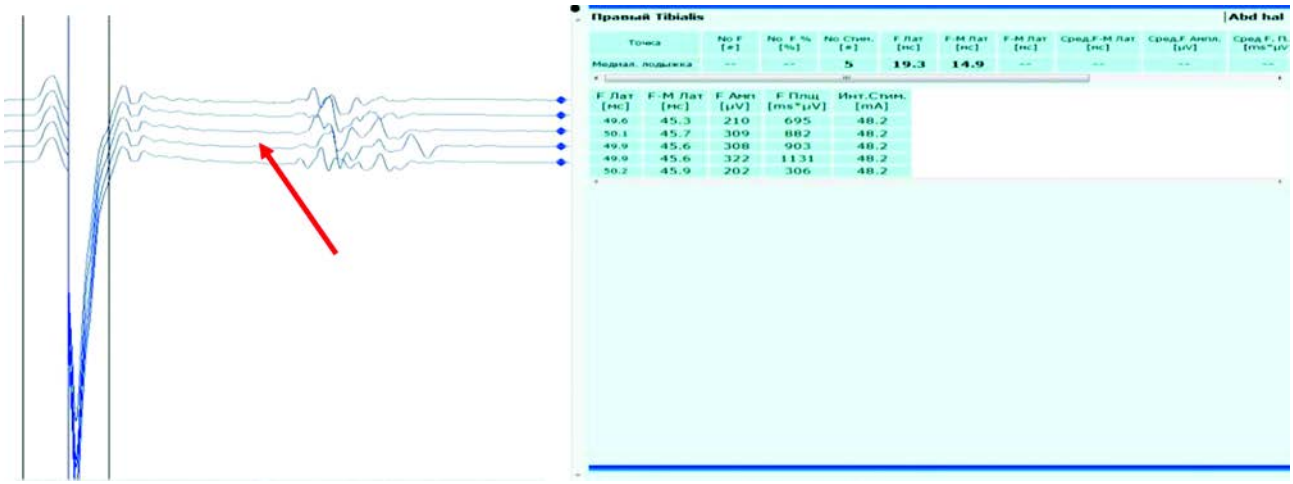

Fig. 1 A-wave recorded during electromyography

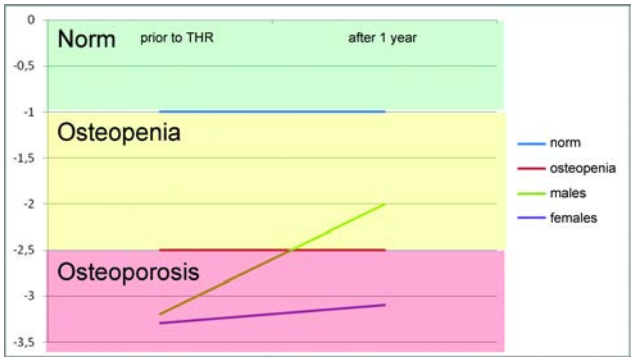

Fig. 2 T-criterion dynamics in males and females after THR

The comparative study of the ENMG findings and densitometry results revealed the dependence of the reduction degree of the conductivity values in the proximal segments and spinal cord roots on the reduction grade of the T-criterion values. In patients with bilateral changes in the electrophysiological findings, the T-criterion value (4.2 SD) corresponded to osteoporosis of a systemic type. Its grade did not depend on patients' age.

In order to objectively assess the functional activity of the lower limb muscles, total EMG findings of the patients were correlated with the normal EMG data of the corresponding age. The results showed that the level of bioelectrical activity in the femur and tibia muscles was reduced in a similar degree of expressiveness both on the fracture side and the contralateral limb in 95 % of the examined subjects. Thereby, the structure of the EMG curves corresponded to the degenerative changes in the muscles.

Therefore, the initial ENMG and EMG values in the patients before the surgery proved the presence of axonal demyelinating lesions in the nerve trunks not only at the levels of the femur and tibia but also of the spinal cord roots in 81.4 % of the cases. In 48.8 % of the cases, the changes were bilateral and impaired the loading of the limb that was intact, especially in the early postoperative period. This ENMG study that was conducted prior to the operation allowed us to detect the signs of local lesions in the sciatic nerve on the pseudarthrosis side that was more frequent in the patients that had been operated previously and was an unfavorable prognostic sign for the development of neurologic complications following THR, in particular in the patients that had a marked limb shortening.

Dynamic neurophysiological examination of group 1 and group 2 patients was conducted after the operation. Upon every clinical and instrumentation examination of group 1 patients, the complex of rehabilitative treatment was corrected in dependence with the dynamic findings obtained. If the results of the complex examination corresponded to the age norm, the treatment was terminated. The course of medication and physiofunctional treatment was repeated in the cases that showed insufficient dynamics during the examination. We developed a method of rehabilitative treatment of the neuromuscular apparatus to be used in the patients with femoral neck pseudarthrosis after THR for activation of the muscles that featured the most reduced EMG characteristics in group 1 [15]. It includes the use of the method for artificial correction of movements (ACM) by means of multichannel electrical stimulation (ES) of the muscles during walking.

The first treatment course comprised not fewer than 10 to 20 sessions that continued 30 or 40 minutes each and did not cause patient's fatigue. The patient walked about 2 km on average during one session. ES was performed most frequently for gluteal muscles, anterior and posterior thigh surface, and for calf muscles if required.

The analysis of the results in group 1 at three months after the operation and after completion of the first course of rehabilitative treatment showed that the amplitude of the muscle activity grew in 68 % of the cases when 10 sessions terminated. In the patients of group 2, EMG values of functional activity in all the muscles studied remained reduced in addition by 20 to 50 % from the initial level that was not observed in the patients of group 1. At six months after the operation, a positive dynamics of the motor response values by 45 to 67 % was observed due to the complex treatment as compared with the patients who had bilateral involvement of peripheral nerve lesions (23-36 %). These patients retained the manifestations of local lesions in the proximal sections, and the conductivity values at the level of the spinal cord roots remained reduced (SPI F not more 41.3 ± 1.3 m/sec).

A positive dynamics in the values of afferent-efferent nerve trunk conductivity was observed in 48 % of patients that had the sings of bilateral axonal-demyelinating lesions before the operation. In group 2 patients, only 38 % of the cases had an increase in ENMG and EMG values but not more than by 23.6 % as compared with the preoperative values (**Fig. 3**).

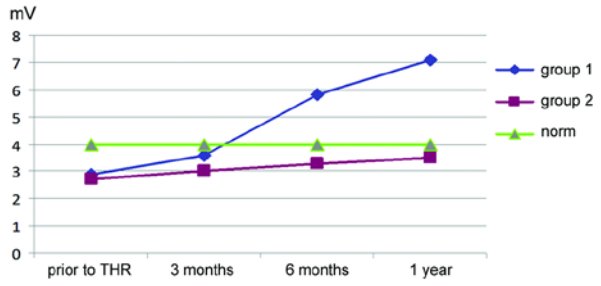

Fig. 3 ENMG dynamics in the 1st year after THR

By the end of the therapy course, EMG values of the anterior femur and tibia muscles were increased by 40 to 50 % while the gluteal muscles bioactivity was higher by 30 % as compared with the initial values ($p < 0.05$) (**Fig. 4**).

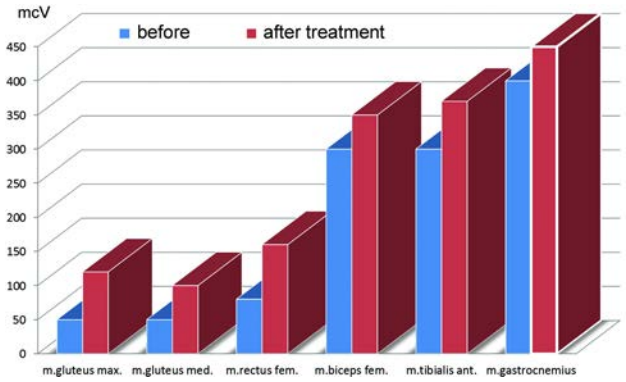

Fig. 4 EMG values dynamics after the course of ACM

At twelve months after surgical treatment, the analysis of the ENMG and total EMG results showed an increase in the amplitude characteristics by 37 to 53 % in group 1 patients that underwent not only a medication therapy but also a percutaneous electrostimulation.

The evaluation of clinical and functional THR results revealed that the low HSS (from 50 to 70 points) in the majority of the cases examined corresponded to poor clinical and functional outcomes. Gradual increase in HSS was observed in all the patients during one year after the surgery but group 1 patients had a more marked positive dynamics in lower limb functions. The difference in the values was more significant in the first three months that may be attributed to active rehabilitation treatment in group 1 patients according to the regime offered (**Fig. 5, Table 1**).

Fig. 5 HSS dynamics after THR

Table 1

HSS results

Patients	Before THR	3 months after THR	One year after THR
Group I	45.09 ± 0.62	69.3 ± 0.49	91.3 ± 0.53
Group II	44.4 ± 0.52	51.2 ± 0.53	79.8 ± 0.51
Total	45.2 ± 0.63	69.4 ± 0.51	91.4 ± 0.53

DISCUSSION

THR in patients with femoral neck pseudarthrosis is always associated with the risk of complications (20-34 %), in particular, in the cases that had previous interventions on this segment. It may be explained by a scarry degeneration in the soft tissues, atrophy and misbalance of the muscles that surround the hip joint. Moreover, acute correction of a considerable limb shortening may be complicated by the damage to the vascular-nervous bundle. Given the specific features of the patients' age, all the patients required an individual approach that takes into consideration the deficit of the functional activity of the nervous and muscular apparatus.

Only a timely onset and persistent rehabilitative therapy that takes into account the initial condition of the nervous and muscular systems will provide maintenance of the operation results as far as the surgery itself is only a phase of a continuous treatment process. The use of the rehabilitation method that has been proposed by us provided an increase of positive outcomes by 12.6 % in group 1 as compared with group 2. The tactics developed could be recommended for use in the medical institutions of Russia for treatment of patients with femoral neck pseudarthrosis.

CONCLUSIONS

1. Preoperative examination of patients with pseudarthrosis of the femoral neck should include the study of the functional activity of the lower limb peripheral nerves, levels of femoral and tibial muscles electrogenesis as well as bone mineral density that will enable an optimal selection of the implant type and aid to specify the complex of rehabilitative measures after THR.

2. The complex of rehabilitative measures that has been developed for patients with femoral neck pseudarthrosis ensures a dynamic control of the neurophysiological parameters of the peripheral nerves, lower limb muscles, bone mineral density as well as individualizes the rehabilitative treatment after THR.

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Received: 05.07.2016

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