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Реферати

ИЗМЕНЕНИЕ МОРФОМЕТРИЧЕСКИХ ХАРАКТЕРИСТИК СОСУДОВ СЕРДЦА ПРИ ЭКСПЕРИМЕНТАЛЬНОЙ ДИСЛИПОПРОТЕИДЕМИИ
Шевчук Т.И., Пискун Р.П., Васенко Т.Б.

В условиях экспериментальной дислипопротеидемии, которую моделировали путем скармливания кроликам холестерина в дозе 0,5 г / кг массы тела в течение 3 месяцев, с помощью морфометрических методов определяли особенности структурной перестройки коронарных артерий. Установили, что при экспериментальной дислипопротеидемии отмечаются признаки выраженного ремоделирования артерий мелкого и среднего калибра, которые проявляются в виде утолщения их стенки и сужения просвета. Более выраженные морфологические изменения обнаружены в сосудах мелкого калибра. Так, площадь просвета артерий мелкого калибра уменьшилась на 48,67%, толщина стенки увеличилась на 42,38% по сравнению с группой интактных животных. Также статистически достоверно изменялись сосудистые индексы: индекс Вогенворта вырос в 4,24 раза, сосудистый индекс - в 2,11 раза, а индекс Керногана снизился в 4,02 раза. Указанные морфометрические изменения приводят к снижению функциональной способности сосудов, нарушению их пропускной способности и, как следствие, ухудшение кровоснабжения тканей миокарда с последующим развитием явлений гипоксии и ишемии.

Ключевые слова: экспериментальная дислипопротеидемия, сердце, сосуды, морфометрия.

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EXPERIMENTAL DYSLIPOPROTEIDEMIA-RELATED CHANGES OF MORPHOMETRIC CHARACTERISTICS OF CARDIAC VESSELS
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The special features of structural transformation of coronary arteries were studied by morphometric methods under conditions of experimental dislipoproteinemia, provided by feeding model rabbits with cholesterol in a dose of 0.5 g/kg of body weight during 3 months. It was established, that the experimental dislipoproteinemia presented the signs of marked remodeling of small and medium arteries, manifested in the form of thickening the walls and narrowing the lumen. Small vessels presented the most pronounced morphological changes. Thus, the lumen of the small arteries decreased by 48.67%, while the wall thickness increased by 42.38% compared with the one in the group of intact animals. Vascular indices also demonstrated statistically significant changes: the Vogenvort index increased by a factor of 4.24, the vascular index – by a factor of 2.11, and the Kernogan index decreased 4.02 times. The above-mentioned morphometric changes lead to a decrease in the functional performance of vessels, a violation of their throughput and, as a consequence, a deterioration of blood supply to the myocardium tissues with subsequent development of hypoxia and ischemia.

Key words: experimental dislipoproteinemia, hearth, vessels, morphometry.

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DEVELOPMENT OF WALKING TRACK DEVICE FOR FUNCTIONAL RECOVERY ANALYSIS AFTER EXPERIMENTAL SCIATIC NERVE INJURY

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The article is devoted to developing devise for Walking track test in rats after experimental sciatic nerve injury. Gradual gait improvement reflects the nerve function recovery in the temporal aspect. Its essence lies in getting rat footprints on paper, witch are analyzed. Then functional sciatic nerve index (SFI) is calculated using a special formula in experimental and intact limbs of the rats. The experiment was performed on outbred male rats (n=15) whom autoneuroplasty was performed. Animals were grouped as following: 1(4) (n=7) tested after 4 weeks of experiment and 1(8) (n=8) – after 8 weeks of experiment. The results shows that functional sciatic nerve regeneration continues during 4 till 8 weeks. This process reflected in SFI improving. Developed walking track device allows to obtain rat footprints simply and fast. The use of Walking track test by using developed device provides a non-invasive method of assessing the functional status of the sciatic nerve during the regeneration process.

Key words: Walking track, sciatic functional index, sciatic nerve injury, functional recovery.

This investigation is the part of SRW "To investigate the effectiveness of novel methods of spinal cord and peripheral nerve restoration with using tissue neuroengineering and electrosurgical technologies in experiment", № 0117U004270.

Recovery of peripheral nervous system in experiment is studied mostly through electrophysiological and morphological techniques. Although these methods very important to know the degree of recovery of peripheral nerve. These classical methods not do not necessarily correlate with recovery of useful limb function. Investigation of functional recovery in animals almost impossible, when using the same methods that use in humans. Functional evaluation in humans is relatively easy. This condition motivated the researchers to developed specific methods, useful in functional evaluation of experimental peripheral injury functional recovery.

Standard model for investigation of experimental peripheral nerve recovery is the sciatic nerve in rats [6]. Experimental sciatic nerve injury always disrupts the nerve functions which a displayed at gait disturbance. Researchers demonstrated that the inability of spreading posterior foot fingers is a reliable parameter to evaluate the degree of injury of sciatic nerve, as well as to follow up recovery [7]. Gradual gait improvement reflects the nerve function recovery in the temporal aspect. The degree of functional deficit is calculated by the method, which is easy and non-invasive. De Medinaceli et al. developed a quantitative, reliable and reproducible method of functional condition of rat sciatic nerve for evaluating injury and recovery degree, named Sciatic Functional Index, which was subsequently modified by other researchers [3, 6, 7]. Its essence lies in getting rat footprints on paper, which are analyzed. Then Sciatic Functional Index (SFI) calculated using a special formula in experimental and intact limbs of the rat. Rat footprints obtain during Walking track test.

Researchers used X-ray developer and film, vaseline and white paper, or grease and polygraph chart paper to observe the prints [7]. These techniques lead to error regarding the actual anatomy of the rat plantar surface. Lowdon et al. report a complex technique requiring dye staining of paper, in which water is utilized to produce a blue track image on yellow brown paper. Johnston et al. conclude that the paint and paper method had many advantages over the original method of X-ray developer and film. The paper is more available than x-ray film, easier to cut and non-toxic [7, 8].

Aim. The aim of our study was to develop the device to optimize the Walking track test to study the functional recovery of the sciatic nerve in the experiment.

Materials and methods. The experiment was performed on outbred male rats (n=20) with body weight average 250±30 g. Rats maintained in collective cages with five animals each, being fed with standard ration and water ad libitum in vivarium of SI "A.P. Romodanov Institute of Neurosurgery of the NAMS of Ukraine". All manipulation were performed in according with the principles of bioethics and biosafety regulations and were approved by the Committee on Bioethics Control of "INH NAMS", law of Ukraine №3447-IV "On protection of animals from cruelty", "European Convention for the protection of vertebrate animals used for experimental and other scientific purposes".

Surgical procedure performed under general anesthesia: intraperitoneal injection of xylazin 15 mg/kg and ketamin 70 mg/kg on body weight. The left sciatic nerve was exposed in all animals under sterile conditions through a muscle-splitting incision. We performed autologous nerve grafting using microsurgical technique under intraoperative magnification ×12. Left sciatic nerve was transected and the gap 10mm was reversed to 180º and sutured to proximal and distal nerve stump with 9/0 Prolene (Ethicon). Muscles, fascia layers and skin were closed with single resorbable stitches (4/0 Prolene, Ethicon). Animals were grouped as following: Gap (4) (n=7) tested after 4 weeks of experiment and Gap (8) (n=8) – after 8 weeks of experiment.

After testing in Gap (4) and Gap (8) groups experimental animals were sacrificed with lethal dose of anesthetics by intraperitoneal injection. Operated segment of the sciatic nerve with proximal and distal ends was removed for morphological analysis.

Sham operated animals (n=5, Sham) using as control group and tested in equivalent time intervals. In this group animals operated as we described upper, accept nerve transection.

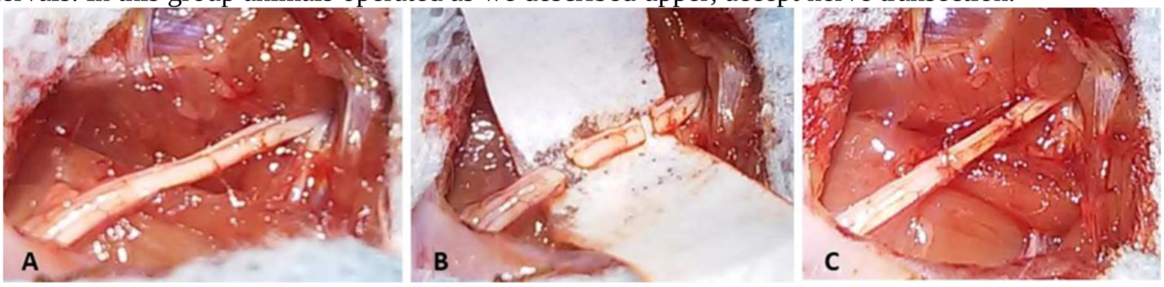


Fig.1. Surgical procedure. A - sciatic nerve exposed; B – sciatic nerve gap performed; C – autoneuroplasty performed.

To obtain the rat footprints we used a specially designed device. It consisted of a wooden pallet with bumpers and half cut plastic pipe over them. This way a tunnel whose bottom was spread with paper was formed. The size of the tunnel excludes animal`s return and the movement was possible only forward. On one end of the pan there was a trough with foam-rubber, impregnated with dye (fukortsyn). The animal put its hindlimbs on foam-rubber and dyed the soles. Then the rat entered the tunnel and the valve was closed. The animal began to move through the tunnel, leaving footprints on paper and walked into the cage, which was located at the opposite end of the tunnel. After that obtained footprints where analyzed and SFI was calculated using formula by Bain, Mackinnon, and Hunter [1, 4]:

SFI=–38,3((EPL-NPL)/NPL)+109,5((ETS-NTS)/NTS)+13,3((EIT-NIT)/NIT)–8,8; PL-print length factor; TS-toe spread factor; IT-intermediate toe spread (N-normal limb, E-experimental limb); SFI= 0 – normal function; SFI= -100 – complete loss of function.

Fig. 2. Walking Track device during obtaining rat footprints. A – general view; B – view of walking animal without half cut plastic pipe.

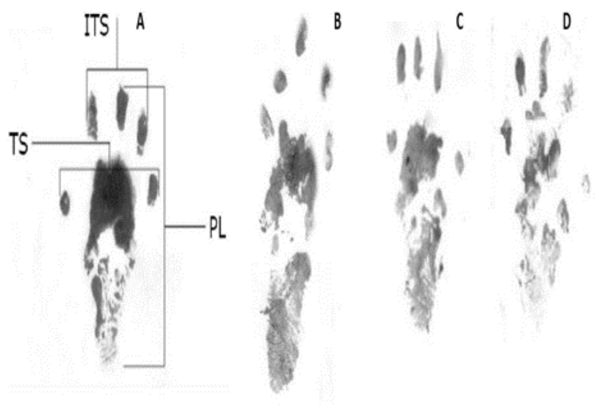
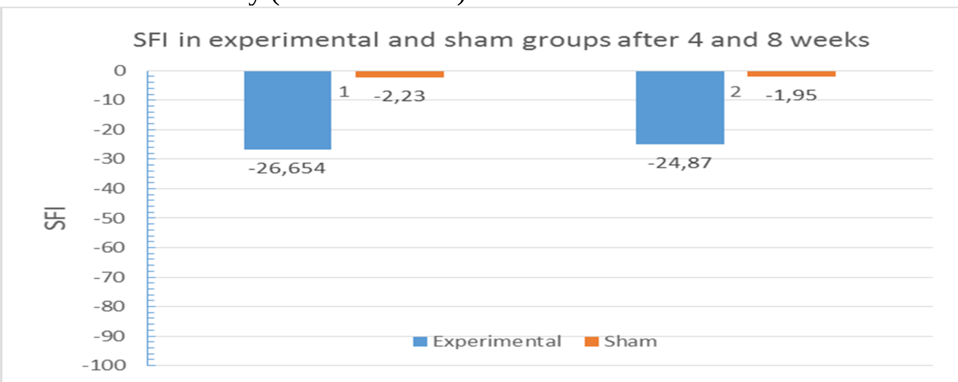


Fig. 3. Rat footprints. A – normal hindlimb; B – experimental hindlimb (after 4 weeks); C – experimental hindlimb (after 8 weeks); D – Sham.

Statistical analysis of data was performed using the statistical software package "Statistica 10.0" (Software StatSoft Inc., 2011). Mann-Whitney U-test used for paired comparison of groups. Data are presented as M ± m (mean ± SE), $p < 0.05$ was considered as statistically significant difference, $p < 0.01$ as highly statistically significant difference.

Results and discussion. The average SFI in Gap (4) and Gap (8) was: - 26,654±2,41 and - 24,87±0,98 respectively. This is shows that functional sciatic nerve regeneration continues till 8 weeks. After 8 weeks regeneration does not occure, because in comparison between group Gap (4) and Gap (8) the difference is not statistically significant (p=0,08). In control group of animals SFI was - 2,23±0,34 after 4 weeks and - 1,95±0,93 after 8 weeks (p=0,01)). This is shows that functional regeneration in intact nerve is absent and it is naturally (SFI is almost 0).



Comparison of Gap (4) and Sham group after 4 weeks and Gap (8) and Sham group after 8 weeks showed statistically significant (p=0,01) impairment of SFI in operated rats which correlate with sciatic nerve function.

Peripheral nerves regeneration seen in experimental studies presents controversial aspects, because it is not always possible to establish a clear correlation between results achieved by different methods in a same investigation. Electrophysiology and morphology are classic and highly informative methods, but they not often correlate with functional sciatic nerve recovery in experiment. Varejão et al. [8], developed a quantitative kinematical method for evaluating sciatic nerve regeneration in rats, based on the measurement of reference between the calcaneus and the fifth and third toes. This method require computer-based analysis and is difficult to apply. Bervar et al., [2] compared video-analysis with SFI and found a positive correlation between each other. He conclude that video-analysis method had advantage of making digital images available. Our devise allows to obtain footprints on paper without expensive digital appliance. The evaluation on the first weeks after sciatic nerve injury was difficult and footprints were bad quality, since palsy imposed to animal's limb precluded a well marked step. Footprints became clearer with the subsequent nerve regeneration and rat hindlimb functional recovery enabling a more adequate marking of footprints. That's why we tested animals at 4 and 8 weeks.

Conclusion

1. Developed walking track device allows to obtain rat footprints simply and fast. The use of walking track analysis by using this device provides a non-invasive method of assessing the functional status of the sciatic nerve during the regeneration process. Method is not expensive and easy, compared to other proposed methods, and these are reason for its wider application.
2. This test can be repeated at any time of the experiment. It is possible to assess the functional recovery of the sciatic nerve in the temporal aspect during different treatment procedures.

Future investigations perspective is to use this devise *for SFI measurement in rats after neural crest multipotent stem cells transplantation in large sciatic nerve gap restoration model.* *Conflict of interest. Authors confirm the absence of any conflict of interests. This research did not receive any specific grant from any funding agency in the public, commercial or not-for-profit sector.*

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Реферати

РОЗРОБКА ПРИСТРОЮ ДЛЯ ПРОВЕДЕННЯ ТЕСТУ З БІГОВОЮ ДОРІЖКОЮ ПРИ ЕКСПЕРИМЕНТАЛЬНОМУ УШКОДЖЕННІ СІДНИЧНОГО НЕРВА

Цимбалюк В.І.1, Петрів Т.І.1, Молотковець В.Ю., Васильєв Р.Г., Татарчук М.М., Буркуш І.І

Розроблено пристрій для проведення тесту біговою доріжкою, для визначення функціонального індексу сідничного нерва, та відновлення корисної функції, після його травматичного ушкодження в експерименті. Робота проведена на безпорідних щурах-самцях (n=15), яким була проведена операція аутонейропластики в експерименті. Для контролю використовувалася група несправжньооперованих тварин (n=5). За допомогою спеціально розробленого пристрою отримували відбитки стоп щурів на папері, які після цього аналізувалися. Розраховувався функціональний індекс сідничного нерва, який є відображенням корисної функції кінцівки після ушкодження сідничного нерва. Визначати функціональний індекс за допомогою даного пристрою можна на будь-якому часовому проміжку експерименту і спостерігати функціональне відновлення в динаміці. Методика є простою, легковідтворюваною, не потребує високовартісних витратних матеріалів та обладнання. Пристрій дозволяє об`єктивізувати ступінь функціонального відновлення сідничного нерва у експерименті та доповнити дані електрофізіологічних та морфологічних методів дослідження.

Ключові слова. Тест з біговою доріжкою, функціональний індекс сідничного нерва, ушкодження сідничного нерва, функціональне відновлення.

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РАЗРАБОТКА УСТРОЙСТВА ДЛЯ ПРОВЕДЕНИЯ ТЕСТА С БЕГОВОЙ ДОРОЖКОЙ ПРИ ЭКСПЕРИМЕНТАЛЬНОМ ПОВРЕЖДЕНИИ СЕДАЛИЩНОГО НЕРВА

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Статья посвящена разработке устройства для проведения теста беговой дорожкой, для определения функционального индекса седалищного нерва, и восстановления полезной функции, после его травматического повреждения в эксперименте. Работа виполнена на беспородных крысах-самцах (n = 20), которым была проведена операция аутонейропластикы в эксперименте. Для контроля использовалась группа ложнооперированных животных (n = 5). С помощью специально разработанного устройства получали отпечатки стоп крыс на бумаге, которые после этого анализировались. Рассчитывался функциональный индекс седалищного нерва, который является отражением полезной функции конечности после повреждения седалищного нерва. Определять функциональное индекс с помощью данного устройства можно на любом временном промежутке эксперимента и наблюдать функциональное восстановление в динамике. Методика проста, легковоспроизводима, не требует дорогостоящих расходных материалов и оборудования. Устройство позволяет обективизировать степень функционального восстановления седалищного нерва в эксперименте и дополнить данные электрофизиологических и морфологических методов исследования.

Ключевые слова. Тест с беговой дорожкой, функциональний индекс седалищного нерва, повреждение седалищного нерва, функциональное восстановление.

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