

13. Pierre N, Appriou Z, Gratas-Delamarche A, Derbre F. From physical inactivity to immobilization: dissecting the role of oxidative stress in skeletal muscle insulin resistance and atrophy. *Free Rad. Biol. Med.* 2016;98:197–207. doi: 10.1016/j.freeradbiomed.2015.12.028
14. Rettori E, De Laurentiis A, Zubilete MZ. Anti-inflammatory effect of the endocannabinoid anandamide in experimental periodontitis and stress in the rat. *Neuroimmunomodulation.* 2012;5:293–303. doi: 10.1159/000339113
15. Selye H. *Stress without Distress.* Philadelphia: Lippincott, 1974. 124 p.
16. Toziuk O. Investigation of effect of sodium 2-(tetrazoloquinazolin-5-ylthio)acetate (compound KB-28) on the metabolic processes in organism during intensive exercise. *Science Rise: Pharmaceutical Science.* 2016;4:60–64. doi: 10.15587/2519-4852.2016.88010

Реферати

ФАРМАКОЛОГІЧНІ ЕФЕКТИ СПОЛУКИ KB-28 ЗА УМОВ ХРОНІЧНОГО ІММОБІЛІЗАЦІЙНОГО СТРЕСУ

Тозюк О.Ю., Кривов'яз О. В., Івко Т.І., Воронкіна А.С.

Натрій 2-(тетразоло[1,5-с]хіназолін-5-ілтіо)ацетат (сполука KB-28) за даними експериментальних досліджень виявляє виразну актопротекторну дію у звичайних умовах. У роботі досліджено вплив сполуки KB-28 за умов хронічного іммобілізаційного стресу. Виявлено, що введення даної речовини підтримує високий рівень працездатності щурів. Це підтверджує наявність у KB-28 актопротекторного ефекту. Доведено, що вказана дія досліджуваної речовини зберігається в ускладнених умовах експерименту. Також встановлено, що натрію 2-(тетразоло[1,5-с]хіназолін-5-ілтіо)ацетату притаманна стреспротекторна дія, що проявилось швидкою адаптацією тварин до умов хронічного іммобілізаційного стресу. За ефективністю сполука KB-28 вірогідно переважала речовину порівняння на 12 та 18-ту добу дослідження.

Ключові слова: натрій-2- (тетразоло [1,5-с] хіназолін-5-ілтіо) ацетат, гідробромід 2-етілтіобензимидазола, хронічний іммобілізаційний стрес.

Стаття надійшла 2.12.2017 р.

ФАРМАКОЛОГІЧЕСКИЕ ЭФФЕКТЫ СОЕДИНЕНИЯ KB-28 В УСЛОВИЯХ ХРОНИЧЕСКОГО ИММОБИЛИЗАЦИОННОГО СТРЕССА

Тозюк Е.Ю., Кривовяз Е.В., Івко Т.І., Воронкіна А.С.

Натрій 2-(тетразоло[1,5-с]хіназолін-5-ілтіо)ацетат (соединение KB-28) по данным экспериментальных исследований оказывает выразительное актопротекторное действие в обычных условиях. В работе исследовано влияние соединения KB-28 в условиях хронического иммобилизационного стресса. Вывявлено, что введение данного вещества поддерживает высокий уровень работоспособности крыс. Это подтверждает наличие у KB-28 актопротекторного эффекта. Доказано, что ука-занное действие исследуемого вещества сохраняется в осложненных условиях эксперимента. Также установлено, что натрию 2-(тетразоло[1,5-с]хіназолін-5-ілтіо)ацетату присуще стреспротекторное действие, на что указывала быстрая адаптация животных к условиям хронического иммобилизационного стресса. По эффективности соединение KB-28 достоверно преобладало над веществом сравнения на 12 и 18-е сутки исследования.

Ключевые слова: натрий-2- (тетразоло [1,5-с] хіназолін-5-ілтіо) ацетат, гидробромид 2-этилтіобензимидазола, хронический иммобилизационный стресс.

Рецензент Дев'яткіна Т.О.

DOI 10.26.724 / 2079-8334-2018-1-63-163-168

UDC 612.741.2:616-089.844-873.4

V. I. Shevchuk, Yu. O. Bezsmertnyi, H. V. Bezsmertna, S. V. Shevchuk
SRI of Invalid Rehabilitation on the base of National Pirogov Memorial Medical University,
Vinnytsya

BONE STUMP FORMATION IN RELATION TO THE MUSCLE TENSION VALUE AT AMPUTATION PLASTIC SURGERY

e-mail: bezsmertnyiyurii@gmail.com

Three series of experiments on 41 dogs with amputation in the medium third thigh and muscular plasty with muscle tension 916-962 μH (experimental group), 980-1100 μH and 650-800 μH (control groups). The monitoring lasted 1 and 3 months. In the 1st series of experiments with muscular tension 916-962 μH , already within one month we observed the formation of the bone cortical endplate, the normalization of intraosseous circulation, with the retention of acylindrical bone stump, the structure of cortical diaphysis plate and the content of the bone marrow channel. During the 2nd series of experiments, 17 out of 19 cases showed the stump formation different from the normal diaphysis: asymmetric axes curvature of the amputated bone, conic thinning or bulbous thickening of the end section, reduction in the diameter through periosteal bone formation (osteogenesis). The 3rd series due to insufficient muscular tension showed incomplete bone marrow closure, abrupt microcirculation distortion and reparatory regeneration failure. Complete (within biological abilities of the bone tissue) stump formation is possible through muscular tension at amputation plasty 916-962 μH . Such stump tends to show fast healing processes and normalization of intraosseous circulation with the formation within 1 month after the amputation of a bone end plate. Muscle plasty with tension 980-1100 μH in most cases leads to distortions in intraosseous circulation, formation of cone-like or through periosteal regenerates, thickened stumps with axis deflation, resorption and fracture of cortical diaphysis plate. Muscular plasty with muscular tension 650-800 μH prevents from occlusion of the bone marrow cavity leading to distortions in microcirculation and reparatory regeneration, with stump formation entirely different from the normal diaphysis.

Key words: amputation, reparatory regeneration, muscle tension, intraosseous circulation.

The research of the issue of extremities amputation is prolific including the recent research devoted to the problems of wound healing prognosis [10], pain syndrome [5-7], amputation techniques in various modifications [1-3, 5]. However, such important issues as healing the bone-saw-line, muscle state, microcirculatory distortion have not been given proper consideration. According to the data [9]

97,1% of the cases presented unsatisfactory bone healing and only 10% of the cases showed the bone stump formation within 1-1,5 month after the amputation [4]. Taking into account that muscle plasty is common for amputations, it was reasonable to study the impact of muscle tension on the outcome of stump formation. The available scientific literature did not report any evidence on this issue.

Purpose of paper was determining the values of muscular tension at amputation plasty sustaining the optimal stump formation.

Material and Methods. Three series of the experiments on 41 dogs with amputation in the medium third thigh and muscular plasty with muscle tension 916-962 μH , 980-1100 μH and 650-800 μH have been carried out. The monitoring lasted 1 month and 3 months. The amputation of the right hind extremity in its medium third was performed under intravenous thiopental narcosis (25 mg per 1 kg of the weight). The perineural anesthesia with 1% Novocain solution was made into the nerve trunks, cut high with a sharp blade. The vessels were tightened with catgut. The bone was sawed aperiosteously with a hand-saw. The muscle tension at plasty was controlled by the tonomyometer. Prior to being taken out from the experiment the dogs were injected with 10000 units of heparin with physiological salt solution intravenously. After 15 min the animals were killed with rapid intravenous injection of sodium thiopental and the abdominal aorta was ligated. Below the ligature a cannula from the system of intra-arterial infusion was injected and fixed in the gap in order to fill the vessels with 10 % ink jellified mixture. The extremity was removed, a piece of muscle for histological chemical examination was extracted; the other muscles were removed leaving a thin layer of tissue attached to the bone. An axial frontal cut 5 cm long was made on the thigh stump and after its decalcification in the 15% nitric acid solution; it was filled with celloidine / photoxylin. Cuts 15-20 μm thick were colored by hematoxylin and eosin and with Van Gieson stain. The cuts were 90-100 μm thick.

The experiments were performed in accordance with the principles of animal human treatment highlighted in the Guidelines of the European Economic Community (86(609) EEC) and the Declaration of Helsinki on the principles of research on animals.

Results and disscution. The first experimental group of animals with muscular plasty presented muscle tension 916-962 μH . The monitoring lasted 1 month and included 8 animals.

According to X-ray and histotopograms the stump was cylindrical. Three of them presented a flat stump sole, another three were rounded and two specimens presented a slight splay. All the specimens had bone end-plates formed on the lower edge of the insignificant endosteal regenerate. The stump was fringed with fiber tissue at the end accompanied by the bundles of muscle fibers sewed on the cut edge during the plasty. In the soft tissue of the stump margin, the bundles of collagen fibers were set laterally in relation to the longitudinal axis. The main contours of the tubular bone and its typical structure remained unchanged. Microscopically all monitorings of the cross-cut end of the endosteal bone regenerate closing the bone marrow channel showed single bone trabeculae fringed with forming bone endplate on the lower edge. In five cases, it was made up of mature, and in three cases of semi-mature bone tissue. In the intra-trabecula grooves of the endosteal bone formation, all specimens had connective tissue with layers of fibro-reticular – osteoblastic tissue and vessels of microcirculation that conformed to the normal diaphysis. The proximal parts of the bone marrow presented fat bone marrow with normally developed micro-vessels.

A 3-month period included 3 monitored cases. According to X-ray and histological topograms the formed stump was cylindrical. Cortical diaphysial plates were well contoured all the way. The stump end acquired a bone end-plate. Microscopically we observed an ostial-trabecular structure of the bone end-plate. It was composed of the mature bone tissue on the edge of endosteously developed bone trabeculae. Intra-trabecular grooves presented fat bone marrow with ink-filled micro-vessels similar to the normal bone vessels. The proximal part of the bone marrow channel was filled with a regular vessel network. The stumps of this series of experiments typically retain cylindrical form, quickly complete reparatory processes and normalize intraosseous circulation with the formation by the end of the 1st month after the amputation of a lateral bone end-plate with the help of endostea and tight muscular closure of the bone marrow channel. The bone marrow channel retaining its typical structure was filled with normal bone marrow tissue attached to the bone-saw line of the fully preserved cortical bone layer. Taking into account the favourable outcomes of the experiments of this series, the muscle tension 916-962 μH was considered to be optimal.

The second group (control) of animals had muscle tension 980-1100 μH . The 1-month period included 5 monitored cases. In all cases, we observed a remarkable conic stump end deformation and irregular thickening of the cortical diaphasic plate. One case presented its fracture with the occlusion of the bone marrow channel. The lower surface of the stump end showed immature bone formations with

fiber cartilage inclusions. Cortical diaphasic plate underwent resorption and showed immature bone trabeculae in this area. There was also irregular cortical diaphasic plate thickening. The proximal part alongside with focal resorption and available immature bone trabeculae showed a fracture in the cortical diaphasic plate. The foci of immature bone tissue in the diaphasic plate were located closer to the periosteum surface. The bone marrow channel was filled with friable fiber tissue with numerous ink-filled thin-walled vessels similar to sinusoids.

Three observations showed monotypic microscopy results. In the narrowed bone marrow channel of the stump butt there was a net of irregularly mature bone trabeculae. In the remarkably thickened end due to periosteal structures of not fully mature bone tissue, they diffused with the fragments of the tabula bone of the diaphasic plate. In other areas due to remarkable resorption of its edges, we observed newly formed intraosseous bone structures that reduced the diameter of the bone marrow channel at the stump end. The distal parts of the irregularly reduced cortical diaphasic plate presented periosteally and endosteously developed immature bone regenerates mixed with the fragments of tabula bone tissue of the plate itself. In the place of its thickening, there was cellular fibrous osteoblastic tissue with osteoclasts. The bone marrow channel of the stump end was filled with friable swelled fibrous tissue with plentiful tissue cysts and ink-filled thin-walled vessels of sinusoid type. In more proximal parts of the bone marrow channel, there were areas of solid fibrous tissue. In the 5th monitoring of this period, the bone structures building the margins of the malformed cone-like stump end are composed of immature newly developed bone tissue due to long lasting resorption of the cortical diaphasic plate. Its fragments are composed of tabula bone and are included into this newly formed regenerate. The conic stump end was closed by the bone tissue and in the bone marrow channel above this level there were solitary trabeculae among the fat swelled bone marrow with layers of friable fibrous tissue. The more proximal parts of the bone marrow channel contained swelled friable fibrous tissue with plentiful large tissue cysts. The thickened sponged cortical diaphasic plate at this level was composed of bone tissue of different maturity degree and remarkable restructuring signs.

The 3-month period comprised 14 cases of monitoring. According to histotopograms, the stump ends varied in form. Only in two cases, the stump resembled the one used in experiments with myodesis and muscle tension 916-962 μH , thus being relatively cylindrical. Because of previous fractures in the cortical diaphasic plate due to its irregular thinning, the stump axis deflated. In the intraosseous stump regenerate, bone trabeculae were interlaced with ink-filled vessels. The bone tissue of the forming bone end-plate is of different maturity indicating about incomplete reparatory processes. Among the bone trabeculae and fiber tissue of the stump end there are lumens of a large branch of the feeding artery. The bone marrow channel of the stump proximal part also contained swelled friable fiber tissue with the vessels of sinusoidal type. In nine specimens, the stump end was conic retaining normal longitudinal bone axis. In other three observations stump form sharply changed due to the angular axial stump end deflection and developing lateral periosteal regenerates. In two cases, the resorption of the cortical diaphasic plate and developing periosteal regenerates lead to the formation of thickened epiphyseal stump end. All microscopic observations of the conic ends found bone trabeculae in the bone marrow channel, while one observation showed its complete occlusion by the fiber tissue in the proximal area and friable fiber tissue in the distal area. Friable fiber tissue contained laminar vessels and large tissue cysts as well as ink-filled sinusoids. In the resorption area of the diaphasic plate in the bone marrow channel, the fiber tissue contained diffusely located macrophage, lymphoid and plasmatic cells. Three of these observations showed continuing massive resorption and irregular thinning of the cortical diaphasic plate which lead to its fractures.

Another three observations with irregular stump form apart from the developed large periosteal regenerate showed the formation of a new regenerate leading to the bone end deflection. There was also focal remarkable resorption of the cortical diaphasic plate all from the edge with inclusions of its mature lamellar bone tissue into the incompletely mature spongy tissue of the replacing it regenerate. The regenerate developed due to periosteal and intraosseous bone formation. There was also alteration in the cortical diaphasic plate in the proximal areas and in one case we observed its fracture. Closer to the end in the bone marrow channel a network of intraosseously developed solitary trabeculae was noted. Among the trabeculae, we detected friable fiber tissue and small areas of the fat bone marrow as well as the ink-filled branch of the feeding artery. Proximal areas of the bone marrow channel are filled with friable fiber tissue with numerous tissue cysts. The bone marrow channel of the deformed butt is occluded with solid fiber tissue. In the cases with developed end similar to the epiphyseal one, periosteal and intraosseous regenerates blend due to remarkable resorption of the cortical diaphasic plate. In the greater part of the bone marrow channel there was friable fiber tissue with numerous tissue cysts and ink-filled thin-walled

wide sinusoid-like vessels. We also detected ink-filled branches of the feeding artery. The lower part of the bone marrow channel was closed with solid fiber tissue.

The third group (control) included animals with muscle tension of 650-800 μH . The observations lasted 1 month and included 5 cases. According to X-ray and histological topograms, all cases presented a cylindrically shaped stump without developed cortical bone end-plate. One case presented deformation and sponging of the margins of the cortical end-plate, stump end dilation due to increase of the diameter of the bone marrow channel, the lower part of which was closed with fiber tissue. Proximally, the bone marrow channel is closed with intraosseous bone regenerate. Only one case showed some quantity of intraosseous spongy regenerate. Three cases showed cartilage areas on the lower edge of the intraosseous regenerate of immature bone tissue. Spaces between trabeculae are filled with cellular fiber tissue with numerous tissue cysts. The feeding artery threw rather large branches from the bone marrow channel to the fiber tissue margining. Above the intraosseous regenerate along the bone marrow channel, there was cell-meagre friable fiber tissue with tissue cysts, sometimes rather big ones. We detected the ink-filled branches of the feeding artery and areas of ink diffusion into the friable fiber tissue due to vessel wall porosity. In two cases, in the middle part of the cortical diaphasic plate, the longitudinal vessel channel location is distorted due to healing of previously occurred fractures. The edges of the cortical diaphasic plate are sponged almost all along.

The observations lasted 3 months and involved 6 cases. According to X-ray and histological topograms all cases presented a cylindrically shaped stump. In other two cases, the diaphasic stump form was sharply distorted because of bone regenerates that developed on its periosteal surface and the butt destruction. In one of these cases, there was a fracture of the cortical diaphasic plate. None of the cases presented a developed cortical bone end-plate. The trabeculae of the intraosseous bone formation closing the end of the bone marrow channel are composed of bone tissue of different maturity degree with irregular margins, restructurings and resorption. Through wide openings in the trabeculae layer of the bone marrow channel of the stump, there came ink-filled branches of the feeding artery. In all observations, the proximal area of the bone marrow channel contained bone trabeculae and ink-dyed swelled fat bone marrow with plentiful sinusoid type vessels. The cortical diaphysial plate is sponged with signs of intense bone tissue alteration. Drawing up the conclusion of the conducted research into the impact of muscle tensions on the outcomes of bone stump formation after the amputation at diaphysis, it should be noted that such incision sharply distorts bone homeostasis. Its regeneration in the remaining bone part implies preserving its normal structure and physiology of the tubular bone. Here, it is necessary to specify the main parameters characterizing such "physiological" stump. Normal diaphysis section of the tubular bone has a cylindrical form, the walls of which are laid with cortical compact bony tissue, while the cavity of the bone marrow channel is occluded. Therefore, it is very important that after reparatory regeneration the bone stump retains its typical structure and form with quick recovery process leading to the closure of the bone marrow channel after the amputation. This closure is necessary for the recovery of intraosseous blood circulation, since its distortion leads to dystrophy of the bone tissue. This all enables to consider the typical, rationally formed bone stump of the diaphysis section of the tubular bone as the one having a cylindrical form with preserved structure of the cortical diaphysis plate and evident throughout its length bone marrow channel, as well as its fast (within 1 month) occlusion on the margin of the bone-saw with a cortical bone end-plate. The specific feature of such bone stump is the completeness of the intensive reparatory processes. The retention of the intraosseous pressure at the amputation is achieved through plastic surgery. Later, this is promoted by fast development of the cortical bone end-plate on the tissue basis.

In the experimental group, the muscle tension 916-962 μH and proper occlusion of the bone marrow channel created the conditions for the reduction of the dissected powerful intraosseous vessels that in the norm provide the adequate blood circulation for the bone. This resulted in normal (within one month after the amputation) completion of all reparatory processes, retention of the stump cylindrical form and formation of a closing cortical bone end-plate. The bone marrow channel preserved its normal structure filled with regular medullar tissues and the stability of such a stump form retained during the whole observation period. In the control experiments, the stump form in most cases differed from the normal diaphysis.

In the experiments with muscle tension 980-1100 μH , all cases showed deformation due to resorption and fractures of the cortical diaphysis stump plate; some cases showed their curvature, the stump butt being formed by the afunctional regenerate and acquiring a conic shape. There was also disruption of the intraosseous circulation. The cortical diaphysis plate recomposed and underwent partial resorption, fractures and deformed during reparatory regeneration processes. The resorption on the

periosteal surface of the cortical diaphysis plate, formation of periosteal regenerates and conic stumps were conditioned by the muscle tension created by plastic surgery. Besides this tension and connected with it formation of the periosteal regenerates, there were remarkable disruptions of medullar circulation, leading to massive resorption of the cortical diaphysis plate and sharp stump bone deformation. Some observations showed narrowing and closure of the bone marrow channel of the conic stump end all way along. In the observations in which the bone marrow channel of the conic stump was not occluded, it was closed by the bone regenerate with signs of pathological alteration, sometimes with inclusions of great vessels coming from the bone marrow channel into the surrounding soft tissues. The development of conic stump-end always occurs because of resorption and atrophy of the sawed off bone, but not its growth in the distal direction from the cut. The bone cortical end-plate was not to be detected.

In the experiments with muscle tension 650-800 μ H, they were not completely attached to the bone cut thus not completely closing the bone marrow channel of the stump. In all cases, the sharp distortion of intraosseous circulation caused remarkable resorption of the sawed bone. Due to incomplete closure of the bone marrow channel, the great vessels were not narrowed, their net sharply expanding over a remarkable part of the opening into the connective tissue covering the stump butt. Therefore, it prevented the development of the complete bone end-plate. The bone marrow channel showed expanded curved branches of the feeding artery and venous sinus coming into the soft tissues. The bone marrow channel at the butt was mainly closed not by bony but fibrous tissue with soft tissue inclusions. The typical feature of the reparatory processes, similarly to the experiments with muscular tension of 980-1100 μ H, was their incompleteness. In observations with both increased and reduced muscular tension as compared to the experimental group, there were immature bony structures, which appeared in connection with continuation of bone formation processes. These processes testified to pathologic alteration which continued alongside with disrupted medullar circulation. The torpid flow of reparatory processes in stump tissues, followed by resorption of the bone stock and formation of new immature bone structures, caused changes in its form and structure, acquisition of untypical for diaphysis of tubular bone signs (asymmetric axis deflection of the dissected bone, conic narrowing or bulbous thickening of the stump, shortening of the stump in comparison with its post-amputation length, due to resorption of the bone stock at the sawed end, fractures of the cortical diaphysis plate).

The terms of developing a bone cortical end-plate, the regenerate quality, intraosseous circulation and the form of the end-section of the stump are decisive factors for the stump functioning. The healing type of the sawed butt at an early stage predetermines the further stump development: either it will be optimal and within 1-3 month sit will retain the form and structure of the bony rest of the end-plate tightly occluding the bone marrow channel with regular medullar tissues and intraosseous circulation, or it will trigger pathological changes worsening the outcome of the amputation. Thus, the degree of tension of the dissected muscles at amputation plasty plays a determining role in the outcomes of the formation processes in the bone stump.

Conclusions

1. Complete (within the biological abilities of the bony tissue) formation of the bone stump is provided by the muscle tension at amputation plasty 916-962 μ H. Such a stump is characterized by quick completion of reparatory processes and normalization of intraosseous circulation, development of the bone end-plate by the end of the 1st month after the amputation, due to endosteum and on the basis of muscular closure of the intramedullary cavity. The last retains its regular structure, being filled with regular intramedullary tissues. The end-plate has compact bony tissue and is attached to the sawed end of the fully preserved cortical bone layer. The stump retained such a stable form during all period of observations.
2. Muscle plasty with muscle tension 980-1100 μ H in most cases leads to disruptions of intraosseous circulation, developing conic or thickened, due to periosteal regenerates, stumps with axial alterations, resorption and fractures of the cortical diaphysis plate. The formation of a conic butt is caused by remarkable resorption of the margins of the cortical diaphysial plate followed by osteogenesis at deficient replacement of the resolved bone. Reparatory processes are not traced.
3. Muscle plasty with muscle tension 650-800 μ H does not allow achieving full closure of the intramedullary cavity, disrupting medullar circulation and reparatory regeneration with stump formation sharply different from diaphysis form.

The prospects of further scientific research can be devoted to the impact of bone plasty on the results of stump shaping.

References

1. Vasilev Alu, Egorova EA, Smyslenova MV. Luchevaia diagnostika izmenenii kultei nizhnikh konechnosti pri protezirovanii. Klinicheskaia medicina. 2013;5(1):51-7.
2. Vasilev Alu, Egorova EA, Vykliuk MV. Kliniko-luchevaia diagnostika izmenenii kulti bedra i goleni posle amputatsii vsledstvie minno-vzryvnoi travmy. Meditsinskaia vizualizatsiia. 2011;1:107-116.
3. Voinovskii EA, Pilnikov SA, Kovalev AS, Barkalev MA, Plin VA. Rezultaty amputatsii nizhnikh konechnosti v sovremennykh vooruzhennykh konfliktakh. Bolezni i poroki kultei. Meditsinskii vestnik MVD. 2015; 78(5):10-14.
4. Xin Zhang, Yongming Xu, Jin Zhou, Shaofeng Pu, Yingying Lv, Yueping Chen, Dongping Du. Ultrasound-guided alcohol neurolysis and radiofrequency ablation of painful stump neuroma: effective treatments for post-amputation pain. J Pain Res. 2017;10:295-302. doi:10.2147/JPR.S127157
5. Kahle JT, Highsmith MJ, Kenney J, Ruth T, Lunseth PA, Ertl J. The effectiveness of the bone bridge transtibial amputation technique: A systematic review of high-quality evidence. Prosthet Orthot Int. 2017;41(3):219-226. doi.org/10.1177/0309364616679318
6. Nijmeijer R, Voesten HGJM, Geertzen JHB, Dijkstra PU. Disarticulation of the knee: Analysis of an extended database on survival, wound healing, and ambulation. J Vasc Surg. 2017;66(3):866-874. doi.org/10.1016/j.jvs.2017.04.052
7. Preißler S, Thielemann D, Dietrich C, Hofmann GO, Miltner WHR, Weiss T. Preliminary Evidence for Training-Induced Changes of Morphology and Phantom Limb Pain. Front Hum Neurosci. 2017;11:319. doi.org/10.3389/fnhum.2017.00319
8. Tosun B, Seleik O, Gok U, Tosun O. Medial gastrocnemius muscle flap for the reconstruction of unhealed amputation stumps. 2017;26(8):504-7. doi.org/10.12968/jowc.2017.26.8.504
9. Weidong Weng, Bin Zhao, Dingshen Lin, Weiyang Gao, Zhijie Li, Hede Yan. Significance of alpha smooth muscle actin expression in traumatic painful neuromas: a pilot study in rats. Sci Rep. 2016; 6: 23828. doi: 10.1038/srep23828.
10. Bosse MJ, Morshed S, Reider L, Ertl W, Toledano J, Firoozabadi R, Seymour RB, Carroll E, Scharfstein DO, Steverson B, MacKenzie EJ. METRC. Transtibial Amputation Outcomes Study (TAOS): Comparing Transtibial Amputation With and Without a Tibiofibular Synostosis (Ertl) Procedure. J Orthop Trauma. 2017; 31(1):63-9. doi: 10.1097/BOT.0000000000000791

Реферати

ВПЛИВ ВЕЛИЧИННИ НАТЯГУ М'ЯЗІВ ПРИ АМПУТАЦІЙНІЙ ПЛАСТИЦІ НА РЕЗУЛЬТАТИ ФОРМОУТВОРЕННЯ КУКСИ КІСТКИ Шевчук В. І., Безсмертний Ю. О., Безсмертна Г. В., Шевчук С. В.

Поставлені три серії дослідів на 41 собаці з ампутацією в середній третині стегна і м'язовою пластикою з натягом м'язів 916-962 мкН (дослідна), 980-1100 мкН і 650-800 мкН (контрольні). Терміни спостереження 1 і 3 місяці. У I серії з натягом м'язів 916-962 мкН вже до місячного терміну формувалася кісткова кортикальна замикальна пластинка, нормалізувалася внутрішньокісткова циркуляція, зберігалася циліндрична форма куksi кістки, структура кортикальної діафізарної пластинки і вмісту кістковомозгового каналу. У другій серії в 17 з 19 спостережень сформувалися куksi, форма яких різко відрізнялась від форми нормального діафіза. У третій серії внаслідок недостатнього натягу м'язів відбувалося неповне за-криття кістковомозгового каналу, різко порушувалася мікроциркуляція і репаративна регенерація. Досконале формування куksi кістки забезпечується натягом м'язів при ампутаційній пластиці 916-962 мкН. Такій куksi притаманні швидке завершення репаративних процесів і нормалізація внутрішньокісткової циркуляції з утворенням вже до кінця I місяця після ампутації замикаючої кісткової пластинки. М'язова пластика з натягом м'язів 980-1100 мкН в більшості випадків призводить до порушень внутрішньокісткової циркуляції, формуванню конусоподібних або потовщених за рахунок періостальних регенератів куksi зі зміною поздовжньої осі, резорбцією і надломами кортикальної діафізарної пластинки. М'язова пластика з натягом м'язів 650-800 мкН не дозволяє досягти герметизму кістковомозгової порожнини, внаслідок чого порушується внутрішньокісткова циркуляція і репаративна регенерація.

Ключові слова: ампутація, репаративна регенерація, м'язове напруження, внутрішньокісткова циркуляція.

Стаття надійшла 10.11.2017 р.

ВЛИЯНИЕ ВЕЛИЧИНЫ НАТЯЖЕНИЯ МЫШЦ ПРИ АМПУТАЦИОННОЙ ПЛАСТИКЕ НА РЕЗУЛЬТАТЫ ФОРМООБРАЗОВАНИЯ КУЛЬТЫ КОСТИ Шевчук В. И., Бессмертный Ю. А., Бессмертная Г. В., Шевчук С. В.

Поставлены три серии опытов на 41 собаке с ампутацией в средней трети бедра и мышечной пластикой с натяжением мышц 916-962 мкН (опытная), 980-1100 мкН и 650-800 мкН (контрольные). Сроки наблюдения 1 и 3 месяца. В I серии с натяжением мышц 916-962 мкН уже к месячному сроку формировалась костная кортикальная замыкательная пластинка, нормализовалась внутрикостная циркуляция, сохранялась цилиндрическая форма культи кости, структура кортикальной диафізарной пластинки и содержимого костномозгового канала. Во второй серии в 17 из 19 наблюдений сформировались культи, форма которых резко отличалась от формы нормального диафіза. В третьей серии вследствие недостаточного натяжения мышц происходило неполное закрытие костномозгового канала, резко нарушалась микроциркуляция и репаративная регенерация. Совершенное формирование культи кости обеспечивается натяжением мышц при ампутационной пластике 916-962 мкН. Такой культе присущи быстрое завершение репаративных процессов и нормализация внутрикостной циркуляции с образованием уже к концу I месяца после ампутации замыкательной костной пластинки за счет эндоста, на основе мышечного перекрытия костномозгового канала. Мышечная пластика с натяжением мышц 980-1100 мкН в большинстве случаев приводит к нарушениям внутрикостной циркуляции, формированию конусовидных или утолщенных за счет периостальных регенератов культи с изменением продольной оси, резорбцией и надломами кортикальной диафізарной пластинки. Мышечная пластика с натяжением мышц 650-800 мкН не позволяет достигнуть герметизма костномозговой полости, вследствие чего нарушается внутрикостная циркуляция и репаративная регенерація.

Ключевые слова: ампутація, репаративна регенерація, мышечное напряжение, внутрикостная циркуляция.

Рецензент Гунас І.В.