# The effect of chronic irritation of biologically active points on reparative osteogenesis in diaphyseal injuries of the forearm bones

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# Influence of chronic irritation of biologically active points on reparative osteogenesis of forearm bones diaphysial injuries

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SUMMARY

Submitted by analysis research results functional fortunes peripheral nerves in the treatment of diaphyseal fractures of the forearm bones using an external fixation apparatus with the introduction of transosseous elements through acupuncture points. It was shown that in the main group, starting from the 7th day after the operation, the parameters of electroneuromyography approached the normal values, while in the group of clinical comparison, the normalization of indicators began from the 20th day and ended 1.5–2 months after the operation. A decrease in the time of fixation in the external fixation apparatus was noted in patients of the main group. During the entire observation period, these patients did not have any complications from the internal organs, or inflammation around the transosseous elements.

Key words: osteogenesis, acupuncture points, external fixation apparatus.

RESUME

The article presents the analysis of the results of the investigation of functional state of peripheral nerves in treatment of diaphysial fractures of forearm bones with application of an external fixation device with insertion of transosteal elements via acupuncture points. It has been demonstrated, that starting from the 7th day of postoperative period in the main group of patients indices of electroneuromyography were close to normal figures, while as in the group of clinical comparison normalization of such indices started from the 20th day and ended in 1.5 –2 months after the surgery. The duration of external fixation was reduced in the main group. The investigators marked neither complications of internal organ diseases nor inflammation around transosteal elements.

Keywords: osteogenesis, acupuncture points, external fixation device.

## Introduction

The method of transosseous osteosynthesis, used in the treatment of injuries of the musculoskeletal system, including the bones of the forearm, is constantly being improved and optimized [12, 13, 16, 18, 19, 20, 21]. The transosseous method is considered to be low-traumatic, providing stable fixation of bone fragments with the possibility of precise, dosed multiplanar action on bone fragments in time (controlled), which makes it possible to rehabilitate patients in a short time [21, 22, 23].

Reparative regeneration of bone tissue as a biological process is genetically predisposed, it goes through certain stages that cannot be accelerated. However, there are factors by which it is possible to influence osteogenesis [7, 9, 10, 24]. Nevertheless, to date, all possible ways of stimulating metabolic processes in bone tissue have not been exhausted. There are publications that testify to the positive effect of reflexotherapy effects on reparative regeneration of bone tissue [4, 14, 17, 18, 19, 20, 21, 22, 23, 25].

Reflexology is characterized by the fact that irritation is on the acupuncture point, an extremely small area of sensitive nerve endings embedded in the skin, muscles, tendons, perivascular plexuses, nerve sheaths. At the same time, reflex reactions of varying complexity develop, leading to a change in the functional state of the central, peripheral, autonomic nervous system with a pronounced effect on tissue trophism. An acupuncture point is an anatomical and topographic zone with receptors and its own functional characteristics [3, 11,15].

It is known that the mechanism of reflexological influence is multilevel, it is customary to distinguish as the main levels: local, segmental, general [3, 8, 11, 26, 27]. The reflex effect, which has arisen in the area of the acupuncture point of irritation, causes an axon reflex and, spreading along the afferent pathways, reaches the spinal cord. From the excitation of the segments of the latter along the afferent pathways through the autonomic ganglia, impulses go to the internal organs, blood vessels, muscles. At the same time, excitement is transmitted to the reticular formation of the brain stem, thalamus, hypothalamus. The response of the hypothalamus is realized through the pituitary gland - the adrenal cortex, the inclusion of the sympathoadrenal system, which causes a change in the level of bioactive substances in the blood, which affects the corresponding processes in the body [3, 8, 11, 26, 27].

The literature describes the positive results of stimulation of bone tissue regeneration in the area of distraction regenerate by acupuncture [4, 5, 16, 17, 18, 19, 20, 22, 23, 25] and by electroacupuncture [7, 24]. These stimulation methods involve the use of regular daily sessions, repeated sessions, and special electrical equipment.

L.N. In an experiment on animals, Solomin and co-authors developed a method for stimulating distraction bone regenerate [22, 23] by introducing transosseous elements into bone fragments through acupuncture points, followed by their attachment in an external fixation apparatus (AVF). According to the authors, this prevents the occurrence of complications from internal organs and inflammatory processes in soft tissues in the area of introduction of transosseous elements, vegetotrophic disorders, and most importantly, the fusion time is reduced due to the stimulation of osteogenesis.

Experimental studies carried out at the Institute of Chemistry of Chemistry have shown that prolonged irritation of acupuncture points by the introduced transosseous elements already on the 20th day of fixation of the AVF leads to the formation of the structure and properties of bone regenerate, which are closest in their characteristics to the parameters of intact bone. Densitometry, MSCT and gammascintigraphy data indicate active remodeling of bone structures under this exposure [18, 19, 20].

The aim of this work was to study the effect of damage and prolonged irritation of acupuncture points by transosseous elements on reparative regeneration of bone tissue in clinical practice with diaphyseal fractures of the forearm bones.

## Material and methods

103 patients with diaphyseal damage to the forearm bones: both bones of the forearm (43), radius (36), ulna (24); 35 women, 68 men, aged 16 to 70. The patients were divided into 2 groups according to the method of fixation of bone fragments. All patients signed an informed consent; the permission of the Ethics Committee of the Institute of Chemistry of Chemistry was obtained.

Clinical comparison group (GCS) - 51 patients underwent surgical treatment in the form of combined transosseous osteosynthesis (CTO), wire-rod arrangement

AVF. The transosseous elements were carried out outside the BAP.

Main group (OG) - 52 patients who underwent transosseous osteosynthesis using an apparatus for external fixation of a rod arrangement with the introduction of transosseous elements into acupuncture points.

To implement this medical technology, the following material and technical support is required:

1. Set for transosseous osteosynthesis according to G.A. Ilizarov consisting of: half rings different diameters; sector 1/4 of the diameter of the ring of the apparatus of G.A. Ilizarov; sector 3/4 of the diameter of the ring of the apparatus of G.A. Ilizarov; intraosseous diaphyseal rods-screws with a diameter of 6.0 mm; knitting needles Ø 2.0 and Ø 1.8 mm; spoke fixers; calibrated track tensioner; brackets with a threaded hole; brackets with a threaded shank; nuts; screws; threaded rods; elements with mutually perpendicular holes.

2. Medical drill. Surgical drills.

3. Apparatus for processing bones with a universal set of instruments AOK UNI-01 "Medsin" (manufacturer - LLC "MEDSIN-MONIKI").

4. Operating tables universal OUK modifications: OUK-01, OUK-02 s kits of devices. Orthopedic attachment to the surgical table (manufacturer - IP "Med-Industry Service", Republic of Belarus).

5. X-ray diagnostic apparatus of the company PHILIPSOPTIMUSCP No. 98-7896, certification GOST R Gosstandart of Russia No. 0641830, CODE TN VED CIS 902221000.

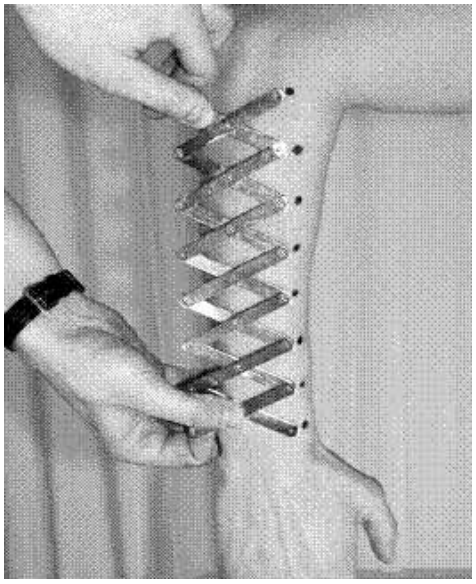
## Preoperative preparation

Indications, contraindications and preoperative preparation are well known, do not differ from those developed at the FGU "RNTs" VTO "them. acad. G.A. Ilizarov for transosseous osteosynthesis of the forearm bones [13].

### General principles of performing transosseous osteosynthesis

The method of transosseous osteosynthesis refers to the type of high-tech medical care and is regulated by the following documents: guidelines No. 2002/134; www.aotrf.org/site/metod.html - "Method of unified designation of transosseous osteosynthesis" (MUOCHO) and an atlas of the conduction of transosseous elements during osteosynthesis with the Ilizarov apparatus [2]. According to these documents, the optimal recommended positions for carrying out transosseous elements at each level of the forearm with full and partial preservation of the rotational movements of the forearm are known.

The technology of transosseous osteosynthesis of diaphyseal fractures of the forearm bones presupposes the preliminary elimination of rough displacement of bone fragments using skeletal traction using a reposition attachment to the operating table and their fixation using an external fixation device.



Rice. 1 Division of a segment into equidistant levels.

The forearm, regardless of the level of the fracture, is set in the middle position between supination and pronation. With the help of distraction, diastasis is achieved between bone fragments of 3-4 mm to facilitate reduction. X-ray contrast marks are applied to the skin surface and X-ray is performed in two standard projections or an image intensifier is used. The segment is divided into eight equidistant levels and the positions of introduction of the transosseous elements are marked (Fig. 1).

For transosseous osteosynthesis, screw rods Ø 6.0 mm are used. For the introduction of the nail-screw, a channel is first made into the bone with a drill Ø 3.2 mm, then the nail-screw is inserted until no more than 3 mm emerges from the second cortical layer. In the metaphyseal area of the bone, it is sufficient to form a canal with an awl. The transosseous elements are fixed to the external support using brackets, washers or in repositioning units.

In previous studies [18, 19, 20], we substantiated the advisability of carrying out transosseous elements on the forearm through 1-2 of 5 acupuncture points: 3 points along the colon canal (GI) and 2 acupuncture points along the small intestine canal (IG) ...

Colon Canal Points:

1. GI6 Pian-li (Lo-point) is located on the front surface of the forearm (on the back radial line according to ZhuLian) between the extensor tendons of 2-3 fingers 3 cun proximal to the fold of the wrist joint (corresponds to position 10, VII level). Topographic anatomy: branches of the radial artery, superficial branches of the radial nerve, external cutaneous nerve of the forearm.

2.GI7 Wen-lu (pain point) is located on the front surface of the forearm (on the dorsal radial line according to ZhuLian) in the middle of the distance from the line of the elbow to the line of the wrist joint in the depression above the radial bone.

Topographic anatomy: branches of the radial artery, superficial branches of the radial nerve, external cutaneous nerve of the forearm.

3.GI 10 Shou-san-li is located on the outer lateral surface of the forearm (on dorsal radial line according to ZhuLian) 2 tsun distal to the elbow bend between the muscles of the long radial extensor of the hand and the brachioradial (corresponds to position 10, level III of the radius). Topographic anatomy: radial artery, radial nerve, dorsal cutaneous nerve of the forearm.

Small intestine canal points:

1. IG 6 Yang-liao (pain relief) is one cun proximal to the IG5 point, located between the styloid process of the ulna and the trihedral bone above the head of the ulna along the posterior-outer surface of the forearm (dorsal-ulnar line according to ZhuLian). Corresponds to position 4, level VII of the ulna. Topographic anatomy: the dorsal artery of the fingers (a branch of the ulnar artery), the dorsal nerve of the fingers extending from the palmar nerve.

2. IG 7 Chzhi-cheng is located above the line of the wrist joint by 5 cun at the elbow the edges of the ulnar extensor of the hand (corresponds to position 4, IV level of the ulna). Topographic anatomy: inner cutaneous nerve of the forearm.

To identify vegetotrophic disorders in the injured limb before surgical treatment and in the early postoperative period, the functional state of the neuromuscular apparatus was studied by stimulating electroneuromyography [4] using the NMA 4-01 Neuromian neuromyoanalyzer. The basis of the stimulation electromyography method is recording the activity of nerves and muscles in response to electrical stimulation. This method helps to differentiate the damage to the muscle, neuromuscular synapse, peripheral nerve, plexus, root or anterior horn of the spinal cord. Determined the thresholds of excitability (PT) when stimulating the peripheral nerves of the upper extremities: n. radialis, n. medianus, n. ulnaris in two groups examined before surgery, in the early postoperative period, and after dismantling the AVF.

## Results and Discussions

Comparative analysis dynamics results functional fortunes of peripheral nerves in the treatment of diaphyseal fractures of the forearm bones by different methods of fixation are presented in table. one.

In the clinical comparison group, when performing transosseous osteosynthesis with the passage of transosseous elements through both bones of the forearm, an initial increase in the threshold values of the muscle response (M-response) was recorded upon stimulation of the radial, median and ulnar nerves by an average of 20% relative to the data of a healthy limb. The least favorable period for the radial and median nerves was the period 7-14 days after the operation, when there was a pronounced decrease in the excitability of peripheral nerve fibers, a decrease in the amplitude of the M-response and the rate of conduction of excitation.

In the main group with separate fixation of each bone and the passage of transosseous elements through biologically active points (BAP), the greatest fluctuations in electrophysiological parameters are observed when stimulating the radial nerve and withdrawing evoked potentials from the motor points of the corresponding zones of the forearm, there is an increase in the excitability of the radial, median and ulnar nerves relative to the data. norms by an average of 12%. Electroneuromyographic indicators for a healthy limb were taken as the norm. One month after the operation, there was a significant increase in the direct M-response threshold by an average of 80% relative to the initial data, and only from the second month after the operation the indicators returned to normal. Upon stimulation of the median nerve, an initial increase in the threshold of excitability was recorded. A combination of axonal lesions of different severity within the same nerve was manifested. Considering that 7 days after the operation, the excitability function was restored by almost 50%, and after 1 month it approached the norm, it can be assumed that the activity of a certain number of axons was changed in a functional, reversible type. The study of the function of the ulnar nerve in this group in the preoperative period and in dynamics after the imposition of the AVF did not reveal any significant violations.

Thus, the initial functional state of the peripheral nerves in patients with diaphyseal fractures of the forearm bones in the preoperative period was impaired. These changes are most pronounced with a diaphyseal fracture of both bones of the forearm, to a lesser extent with a fracture of only the radius or only the ulna.

Surgical treatment with external fixation devices leads to an even more pronounced dysfunction of excitability and conduction of the nerves of the forearm for 2-3 weeks of the postoperative period, the main prerequisites for this are nerve compression due to edema and pain. These changes are manifested in an increase in the threshold of the M-response, a decrease in its amplitude, a change in the shape of the evoked potential (EP), as well as a decrease in the rate of conduction of excitation along motor vegetative fibers.

It is quite obvious that the clinical picture of the lesion of the peripheral nervous system corresponded to the localization of the traumatic effect, with disorders of sensitivity and autonomic disorders in the zone of innervation. The above-described dynamic shifts in the functional state of the neuromuscular system occur when long segments of the nerves are damaged during their stretching, as well as compression or contusion, and in patients with a fracture of the radial diaphysis, gross violations were observed when transosseous elements were passed through both bones of the forearm.

The dynamics of electroneuromyography indices in the group of patients with diaphyseal fractures of the forearm bones, in whom the transosseous elements were passed through biologically active points, indicates less pronounced vegetotrophic disorders. In a similar observation period, starting from the 7th day after the operation, ENMG parameters during stimulation of the peripheral nerves of the forearms in the main group approached the normal values, while in the clinical comparison group, the normalization of indicators began from the 20th day and ended after 1, 5–2 months after surgery. A decrease in the time of fixation in the AVF was noted in patients who received transosseous elements through biologically active points. We associate this decrease with the stimulation of osteogenesis.

With an unfavorable effect of the transosseous elements on BAP or meridians in the groups examined, it was possible to expect the occurrence of acute or exacerbation of chronic diseases of the gastrointestinal tract (GI, IG). In our case, no manifestations of diseases of internal organs were recorded in the groups surveyed for the entire observation period. Inflammation around the wires and rods did not occur in any patient.

In the study of the functional state of the neuromuscular apparatus, it was found that in all groups of patients there was an initial asymmetry in the parameters of excitability from 9–12% to 26% relative to the values of the intact limb (Table 1).

Thus, in the group of patients of the main group, there were no complications from both internal organs and inflammatory processes of soft tissues around the transosseous elements.

The indicators of stimulation electromyography in the group of patients in whom the transosseous elements were passed through biologically active points indicate less pronounced vegetotrophic disorders than in the clinical comparison group: given that in the main group, the normalization of excitability processes begins from 7 days after the operation, and In the clinical comparison group, these processes return to normal only 2 months after surgery, it can be concluded that this method of surgical treatment is more optimal and reduces the repair time by 2–2.5 times.

A decrease in the time of fixation of bone fragments in the external fixation apparatus was noted in patients of the main group.

Our research has proven that the introduction of transosseous elements through the acupuncture points when performing transosseous osteosynthesis is advisable to stimulate osteogenesis.

Table 1

Dynamics of electrophysiological parameters of peripheral nerves in patients with diaphyseal fractures of the forearm bones in the study group and in the clinical group.

comparisons

| Показатели | Группы | До операции | После операции | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 сутки | 7 сутки | 14 сутки | 21 сутки | 2 мес. | После демонтажа |
| **n. radialis** | | | | | | | | |
| Порог (мА) | ОГ<br>ГКС | 23,5 ± 7,4*<br>25,3 ± 7,4* | 20,2 ± 5,9<br>26,8 ± 5,9* | 18,1 ± 6,5<br>28,1 ± 6,5* | 18,0 ± 6,7<br>28,0 ± 7,0* | 19,0 ± 6,0<br>23,6 ± 7,0 | 17,7 ± 7,5<br>17,3 ± 7,5 | 16,6 ± 6,8<br>16,6 ± 8,0 |
| Амплитуда (мВ) | ОГ<br>ГКС | 0,89 ± 1,0*<br>0,91 ± 0,9 | 0,97 ± 0,57*<br>0,57 ± 0,57* | 1,1 ± 0,36<br>0,64 ± 0,36* | 1,2 ± 0,66<br>0,84 ± 0,61* | 1,1 ± 0,11<br>0,93 ± 0,11 | 1,17 ± 0,47<br>1,17 ± 0,67 | 1,2 ± 0,1<br>0,9 ± 0,1 |
| Латентность (мс) | ОГ<br>ГКС | 5,8 ± 2,2*<br>5,8 ± 2,4* | 5,2 ± 2,3<br>6,0 ± 2,3* | 5,5 ± 2,5<br>6,5 ± 2,6* | 5,4 ± 2,6<br>6,4 ± 2,6* | 5,2 ± 1,0<br>5,7 ± 1,0* | 4,9 ± 2,0<br>4,9 ± 2,0 | 4,9 ± 1,9<br>5,3 ± 1,9 |
| **n. medianus** | | | | | | | | |
| Порог (мА) | ОГ<br>ГКС | 18,0 ± 5,4*<br>17,0 ± 5,5 | 17,8 ± 6,7<br>21,8 ± 6,7* | 14,7 ± 6,7<br>21,7 ± 7,0* | 14,1 ± 6,9<br>20,1 ± 6,9* | 14,3 ± 5,6<br>14,3 ± 5,6 | 14,8 ± 5,1<br>15,8 ± 5,8 | 14,0 ± 5,5<br>15,5 ± 5,6 |
| Амплитуда (мВ) | ОГ<br>ГКС | 1,0 ±0,79*<br>1,1 ± 0,76* | 1,5 ± 1,0<br>1,5 ± 1,0 | 1,5 ± 0,88<br>1,1 ± 0,84* | 1,4 ± 0,6<br>0,92 ± 0,19* | 1,6 ± 0,48<br>1,2 ± 0,48 | 1,8 ± 0,15<br>0,96 ± 0,05 | 1,8 ± 0,14<br>1,1 ± 0,14 |
| Латентность (мс) | ОГ<br>ГКС | 7,8 ± 1,7*<br>7,8 ± 1,7* | 7,0 ± 1,6<br>7,9 ± 1,6* | 7,0 ± 1,8<br>8,3 ± 1,8* | 7,3 ± 1,2<br>8,3 ± 1,0* | 7,0 ± 1,4<br>8,0 ± 1,4* | 6,9 ± 1,4<br>8,1 ± 1,4* | 6,8 ± 1,9<br>8,1 ± 1,9* |
| **n. ulnaris** | | | | | | | | |
| Порог (мА) | ОГ<br>ГКС | 12,5 ± 5,0<br>12,5 ± 5,0 | 10,8 ± 5,1<br>14,8 ± 8,1 | 10,8 ± 5,2<br>12,8 ± 6,2 | 11,6 ± 5,2<br>15,6 ± 7,9 | 11,5 ± 5,2<br>14,5 ± 5,2 | 10,8 ± 5,6<br>15,8 ± 5,8 | 9,0 ± 5,2<br>9,0 ± 5,2 |
| Амплитуда (мВ) | ОГ<br>ГКС | 1,0 ± 0,29*<br>1,0 ± 0,29 | 1,2 ± 0,41<br>1,2 ± 0,41 | 1,3 ± 0,28<br>0,97 ± 0,28* | 1,4 ± 0,36<br>1,0 ± 0,42 | 1,5 ± 0,63<br>1,5 ± 0,63 | 1,42 ± 0,99<br>1,2 ± 0,99 | 1,5 ± 0,25<br>1,1 ± 0,21 |
| Латентность (мс) | ОГ<br>ГКС | 6,1 ± 1,5*<br>6,1 ± 1,5* | 5,2 ± 0,29<br>5,2 ± 0,29 | 5,4 ± 2,6<br>6,7 ± 2,6* | 5,9 ± 2,9<br>6,9 ± 2,9* | 5,3 ± 0,77<br>5,3 ± 0,57 | 5,3 ± 1,1<br>5,9 ± 1,1 | 5,4 ± 1,0<br>5,4 ± 1,0 |

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Influence of chronic irritation of biologically active points on reparative osteogenesis in diaphyseal injuries of the forearm bones. Verkhozina, M.E. Puseva, E.G. Ippolitova, I.N. Mikhailov, N.I. Arsentieva // Traditional medicine. - 2015. - No. 1 (40). - S. 35-41.