The Use of Magnetic-laser Therapy in the Rehabilitation Period for Patients with Infraorbital Nerve Damage

Wykorzystanie magneto- i laseroterapii w okresie rehabilitacyjnym u pacjentów z uszkodzeniami nerwów podoczodołowych

DOI 10.36740/ABAL202103106

Nataliia G. Gadzhula, Oleksandr S. Barylo, Ruslan L. Furman, Tetiana O. Rekun

National Pirogov Memorial Medical University, Vinnytsia, Ukraine

SUMMARY

Aim: The aim of the study was to assess the effectiveness of magnetic-laser therapy in complex treatment of patients with zygomatic fractures accompanied by the infraorbital nerve damage.

Materials and Methods: The study included 32 patients with single fractures of the zygomatic bone accompanied by infraorbital nerve injury. Patients were divided into two groups: the main group (n=17) and the control one (n=15). In both groups the complex treatment was used, which included: the fragment reposition operation, broad-spectrum antibiotic, nonsteroidal anti-inflammatory drug, anti-edematous therapy, vitamin B complex. In the main group of patients in the postoperative period the magnetic-laser therapy was applied. Assessment of qualitative and quantitative indices of pain was carried out on the 1st, 7th and 14th days of treatment.

Results: In the main group of patients the magnetic-laser therapy significantly reduced the intensity of nociceptive pain, led to moderate regression of all types of neuropathies associated with infraorbital nerve damage. When comparing 2 groups the best pain relief had patients of the main group. At the end of treatment a significant positive dynamics of improving the electrical sensory of infraorbital nerve has been noted, as indicated by recovery of sensory threshold, pain threshold and pain tolerance almost to the level of intact contralateral side.

Conclusions: The use of magnetic-laser therapy in the combined treatment of infraorbital nerve damage allows to improve the recovery of infraorbital nerve sensory changes following zygomatic fractures, reduce the pain, increase the effectiveness of treatment and provide rapid postoperative rehabilitation of patients.

Key words: zygomatic fracture, infraorbital nerve injury, magnetic-laser therapy, pain and sensory dysfunctions

Słowa kluczowe: złamanie jarzmowe, uszkodzenie nerwu podoczodołowego, magneto- i laseroterapia, ból i zaburzenia czucia

Acta Balneol, TOM LXIII, Nr 3(164);2021:165-169

INTRODUCTION

Among all facial bone fractures, the priority belongs to zygomatic bone fractures, which according to various authors is from 35 to 43% of all cases of facial injuries [1]. The most common fracture occurs within the inferior orbital margin in the zone of the infraorbital canal. The fractures of zygomatic bone are associated with the damage of infraorbital nerve in the canal [2, 3]. In the complex therapy of nerve fiber injuries traditionally use vasoactive drugs, antithrombotic and anti-fibrinolytic drugs, diuretics, psychotropic substances and nootropic agents that indirectly act on the infraorbital nerve through the trophic recovery of surrounding tissues. Low level laser therapy has become very popular in the last decade due to the multifactorial effects, simplicity and atraumatic nature of the technique, the absence of allergic reactions [4]. Magnetic-laser therapy (MLT) is a combined effect on the body with the therapeutic and prophylactic action with a magnetic field and low-intensity laser therapy. It is known that combined physiotherapeutic methods should be based primarily on the synergism of the biological action of different therapeutic physical factors in one procedure. Both magnetic field and laser therapy have trophic-regenerative, anti-inflammatory, analgesic, anti-edematous, immunomodulatory and other effects [5, 6]. Due to these effects, magnetic therapy is widely used for injuries. Physical methods play an important role in the treatment and rehabilitation of the patient [7, 8]. Their choice depends on the time, passed after the trauma [9]. It is recommended to use MLT in the absence of purulent-inflammatory complications of maxillofacial bone fractures in 3-4 days after injury.

In the literature there is insufficient data about MLT usage for infraorbital nerve injuries. Therefore, we consider

it necessary to study the effect of MLT (permanent magnet + low-intensity laser radiation of the red) on the process of function recovery of the infraorbital nerve injury following zygomatic fractures.

AIM

The aim of the study was to assess the effectiveness of magnetic-laser therapy in complex treatment of patients with zygomatic fractures accompanied by the infraorbital nerve injury in the rehabilitation period.

MATERIALS AND METHODS

Operative and postoperative treatment of 32 patients (28 males and 4 females, aged 18 to 38 years) with single fractures of the zygomatic bone without bone fragment dislocation accompanied by a clinical manifestations of infraorbital nerve damage were carried out. The patients were divided into two clinical groups: the main group (n=17) and the control group (n=15). In both groups a complex treatment was performed, which included: the operation for bone fragment reposition, administration of broad-spectrum antibiotic and nonsteroidal anti-inflammatory drug, anti-edematous therapy, antihistamine, vitamin B complex. Dosages of medicines were prescribed according to the guidelines. All treatment procedures were agreed with the neurologist, who carried out daily monitoring of treatment effectiveness of these patients. The average duration of in-patient treatment and hospital stay was 13.8 days.

In the main group of patients in the postoperative period the physiotherapy treatment was applied using the Uzor-A-2K MLT device. This device includes low-intensity pulse laser with radiation in the red spectrum (630 nm) and magnetic attachments. The following parameters were used for the treatment: wavelength 0.89±0.02 μm, impulse radiation mode, pulsed wave frequency 80 Hz, pulse power up to 5 W, magnetic induction is 60 mTl. The patients had 7 procedures lasting 20 min daily.

The study was performed in Maxillofacial Surgery Department of Vinnytsia City Clinical Emergency Hospital. For the possibility of adequate processing of study data, patients with fractures of zygomatic bone (isolated unilateral, without clinical manifestations of nerve damage on the opposite side) were selected. At the same time, there was either no fragments dislocation in the patients or it measured to 0.5 cm.

The severity of pain syndrome and neuropathy symptoms were evaluated using the Leeds Assessment of Neuropathic Symptoms and Signs (LANSS pain scale; M. Bennett, 2001), Douleur Neuropathique 4 (DN4) questionnaire (Bouhassira D. et al., 2005), the Visual Analogue Scale (E.S. Huskisson, 1974) and Neuropathy Total Symptom Scores (NTSS-9). For the quantitative objective assessment of sensory changes, we used the method of determining the threshold of pain sensitivity in the projection zone of the infraorbital nerve using Pulp Tester DY310 device. The sensory threshold, pain threshold and pain tolerance were determined [10].

The complex of studies was carried out three times during the treatment period: at the time of hospitalization (the first day), on the 7th and 14th days of treatment. The requirement for all patients was to undergo a course of treatment without NSAIDs with analgesic effect, that could confound the study results. This was achieved by the following ways: at the day of hospitalization the examination was performed as soon as possible before the appointment of drugs, on the 7th and 14th days of treatment – in the morning prior to therapeutic manipulations (not less than 6 hours after the previous drug administration). Due to the fact that the antibacterial drug included in complex treatment had no influence on the study results, it was used according to conventional treatment regimen equally in both groups of patients.

Statistical analysis of the study results was carried out using computer programs Microsoft® Excel 2017 for Mac (corporate license, Product ID: 02984-001-000001; Device Code: 86C36D0C-8F15-59CA-A81E-B1D889205F71) and the licensed package "Statistica 6.1" (serial number BXXR901E246022FA). Statistical data processing was performed by method of the Student parametric criterion according to the principle of variation statistics. Values of $p < 0.05$ were considered statistically significant.

The work is a fragment of the research project "Development of methods of surgical treatment of patients with maxillofacial pathology considering correction of concomitant diseases", state registration № 0118U005403.

The studies were carried out in compliance with the main provisions of the "Rules of ethical principles for performing the scientific medical researches with human participation", approved by the declaration of Helsinki, ICH GCP, EEC Directive №609, orders of the Ministry of Health of Ukraine №690 dated 23.09.2009, №944 dated 14.12.2009 y., №616 dated 03.08.2012. The study protocol was approved by the biomedical ethics committee of National Pirogov Memorial Medical University, Vinnytsya.

RESULTS

Patients of both groups with zygomatic fractures (not accompanied by displacement of bone fragments) had a mild injury degree. It was an injury of infraorbital nerve, which can be characterized as neuropraxia. Patients complained of numbness and pain in the entire cheek, the ala of nose, and upper lip. During skin electrosensometry in projection of the infraorbital foramen on the side of the trauma the decrease of skin sensitivity was diagnosed – 42.5 ± 5.4 μA. In a day after surgery operation in both clinical groups the significant increase of sensory threshold (45.6 ± 1.7 s.u.), pain threshold (57.9 ± 2.1 s.u.) and decrease of pain tolerance level (77.2 ± 1.9 s.u.) were diagnosed, indicating a significant violation of sensory excitability of infraorbital nerve compared to normal values ($p < 0.05$) and insufficient functional activity of the antinociceptive system in these patients (Table 1).

To differentiate nociceptive painful syndrome from neuropathic pain the LANSS scale assessment of neuropathic pain was used. Using the LANSS pain questionnaire, the signs of allodynia, impaired sensitivity in the innervation area as well as the intensity and character of the pain were revealed.

Table 1. Indicators of electrical excitability of the infraorbital nerve in treatment dynamic, s.u.

Terms	Sensory threshold		Pain threshold		Pain tolerance	
	Main group	Control group	Main group	Control group	Main group	Control group
	In norm – 15.76 ± 1.38		In norm – 36.83 ± 1.34		In norm – 52.46 ± 1.56	
1st day	45.83±1.62 p< 0.05	45.41±1.66 p< 0.05 p_1> 0.05	58.03±2.19 p< 0.05	57.67±2.11 p< 0.05 p_1< 0.05	77.26±1.82 p< 0.001	77.12±1.85 p< 0.001 p_1> 0.05
7th day	36.20±1.42 p> 0.05	42.58±1.64 p< 0.05 p_1> 0.05	47.43±1.45 p> 0.05	52.90±1.91 p< 0.05 p_1< 0.05	66.86±1.73 p< 0.001	73.74±1.81 p< 0.001, p_1< 0.05
14th day	20.16±1.42 p> 0.05	37.54±1.55 p> 0.05 p_1< 0.05	38.23±1.45 p> 0.05	47.41±1.28 p> 0.05 p_1> 0.05	53.30±1.52 p> 0.05	66.16±1.8 p< 0.05, p_1< 0.05

Note: p – the significance of the difference between the values in norm and during treatment (1st, 7th, 14th day); p_1 – the significance of the difference between the values of the main and the control groups.

Table 2. Indicators of the pain scales in the patients with zygomatic fractures, accompanied by infraorbital nerve damage, scores (M ± m)

Group of patients	1st day	7th day	14th day
LANSS pain scale			
Main group (n=17)	22.81 ± 3.2	10.05 ± 1.7	9.62 ± 1.2
Control group (n=15)	22.73 ± 3.1 p > 0.05	18.21 ± 2.2 p < 0.01	17.54 ± 2.2 p < 0.01
Douleur Neuropathique 4 questionnaire			
Main group (n=17)	9.54 ± 0.70	7.76 ± 0.61	5.71 ± 0.51
Control group (n=15)	9.52 ± 0.68 p > 0.05	8.54 ± 0.63 p > 0.05	7.36 ± 0.65 p > 0.05
Visual-Analogue scale (VAS)			
Main group (n=17)	7.69 ± 0.83	1.71 ± 0.44	0.28 ± 0.46
Control group (n=15)	7.67 ± 0.49 p > 0.05	5.48 ± 0.50 p < 0.001	3.87 ± 0.69 p < 0.001
General assessment of neuropathic symptoms scale (NTSS-9)			
Main group (n=17)	22.21 ± 2.11	13.66 ± 1.94	6.03 ± 1.59
Control group (n=15)	22.18 ± 2.12 p > 0.05	17.66 ± 2.15 p > 0.05	14.60 ± 1.32 p < 0.001

Note: p – the significance of the difference between the indexes of the main and control groups.

In general, the average indices in the examined patients were 22.77 ± 3.2 scores. Decreased scale indices were determined in both groups, indicating the pain reduction. This is due to the fact that in the absence of inflammatory complications, after the acute period (1-3 days) regeneration occurs in the fracture zone, leading to reduce the pain syndrome. However, the pain reduce was not the same in two groups of patients (Table 2): on the 7th day of treatment the obtained results were 10.05 ± 1.7 scores in the main group and 18.21 ± 2.2 scores in the control group; on the 14th day – 9.62 ± 1.2 and 17.54 ± 2.2 scores, respectively. It is seen that the indices are significantly better in the main group on the 7th and 14th days than in the control group (p<0.01). Analyze the data of LANSS pain scale in the main group, it is revealed that a sharp decrease is observed due to the parameters that characterize nociceptive pain. In the future, the indices are almost unchanged, and are preserved due to signs of disesthesive manifestations.

A diagnostic DN4 questionnaire for neuropathic pain was used to analyze sensory changes. Thus, when using the DN4 questionnaire 84.4% patients in both groups a neuropathic character of pain was revealed; the average indices were 9.53 ± 0.6 scores. In general, the results confirm the high frequency of neuropathic pain in zygomatic bone fractures and involved neurogenic mechanisms in the formation of pain inherent to the infraorbital nerve damage.

At the beginning of the study, there was almost no difference between the indices, moreover, they were somewhat higher in the main group (Table 2). In 7 days of treatment, the values of indices in the main group were lower by 1.1 times and in 14 days by 1.29 times than in the control group. Since this questionnaire mainly characterizes the signs of disesthesive signs, we can assume that MLT has little effect on the regression of these manifestations in fractures.

When analyzing the indices of Visual-Analogue scale (VAS), the obtained results show the tendency of VAS scores to reduce the pain in both treatment groups. Significantly more rapid pain relief was revealed in the main group. On the 7th day of treatment the indices of VAS in the main group were 1.71 ± 0.44 scores against 5.48 ± 0.50 scores in the control group ($p<0.001$); on the 14th day – 0.28 ± 0.46 scores against 3.87 ± 0.69 scores ($p<0.001$), respectively. It means that on the 7th day the VAS scores were lower by 3.2 times, and at the time of discharge from the hospital (14th days) in patients the indices were 13.8 times lower than in the control group. This shows that the pain syndrome (mainly spontaneous pain and pain during exercise) in the main group at the time of discharge from the hospital was almost absent and patients did not need to use any painkillers. Whereas in the control group there was moderate pain that required the use of analgesics.

The results of the study by NTSS-9 scale are as follows (Table 2): in the main group the indices were not differ significantly on the 1st and 7th days of observation compared to the control group ($p>0.05$), on the 14th day we noted a significant reduction ($p<0.001$) of neuropathy symptoms in the main group of patients: 6.03 ± 1.59 scores against 14.60 ± 1.32 scores in the control group. There were the clear-cut differences between the groups in the dynamics of improvement of patients' state. At the first day, the indices were similar, being even somewhat higher in the main group of examined patients. In 7 days, the difference was 1.29 times lower and in 14 days – 2.42 times lower in the main group than in the control group.

Thus, as the LANSS, DN4, VAS and NTSS-9 scales characterize pain syndrome from various perspectives, the results were different with existing similar tendency.

Determination of electrical excitability of nerve fibers in patients who used the traditional scheme of postoperative rehabilitation, statistically confirmed a significant violation of the sensory threshold, pain threshold, pain tolerance (Table 1). In the main group, a significant positive dynamics in improving the electrical excitability of the infraorbital nerve was determined. The sensory threshold, pain threshold and the level of pain tolerance were recovered almost to the level of the intact side at the end of observation.

DISCUSSION

Approximately 30% to 80% of patients with zygomaticomaxillary complex fractures experience infraorbital nerve injuries [1]. Infraorbital nerve damage causes symptoms like mild numbness in the sensory dermatome and sensory loss, ranging from complete anesthesia to dysesthesia [11]. This complication leads to psycho-emotional disorders and significantly impairs the quality of person's life [3]. Gradual nerve function recovery was confirmed to be possible with conservative treatment and rehabilitation alone [6, 8, 12]. That is why, MLT in the rehabilitation period for patients with zygomatic bone fractures has been investigated because of its intimate relationship with tissue recovery processes, such as on infraorbital nerve damage.

After analyzing the dynamics of complaints and objective data in zygomatic bone fractures accompanied by infraorbital nerve injury, it was revealed that the use of MLT with a red laser and a constant magnetic field accelerates the pain reduce during treatment. This physiotherapy procedure significantly reduces the intensity of nociceptive pain, leads to moderate regression of all types of neuropathies associated with damage to the infraorbital nerve, namely: shooting pain, sensations of burning and coldness, aching pain, allodynia, static hyperalgesia, tingling, cramps (twitching).

An analysis of pain scales and questionnaires seen the following patterns: on the 7th day of treatment the indices of VAS scale in the main group were lower by 3.2 times than in the control group ($p <0.05$), and on the 14th day – 13.8 times ($p <0.05$), respectively. It was revealed that the indices of spontaneous pain by LANSS scale, on the 7th day of observation in the main group was significantly reduced by half, on the 14th day by 2.37 times ($p <0.01$). In the control group, the decrease of indices for 14 days of observation occurred 1.3 times. On the 14th day, the indices of pain by NTSS-9 scale in the main group showed a significant decrease to 6.03 ± 1.59 scores (2.42 times) compare to the control group, where the indices were 14.60 ± 1.32 ($p <0.001$). The clinical effectiveness of MLT for treatment of infraorbital nerve injuries is proved, the use of which provides significant analgesic and anti-inflammatory effects, which reduces the use of analgesics by 6.24 ± 0.71 days.

A significant pain reduction and sensory recovery of the infraorbital nerve on the 7th and 14th days of observations in patients of the main group compared to patients of the control group shows the effectiveness of physical therapy procedures. Effectiveness of MLT on pain relief can be explained by the fact that laser light absorbed by nociceptors, exert an inhibitory effect on A and C pain fibers, which slows conduction velocity, and suppresses neurogenic inflammation [5]. The peripheral nervous system reacts to the magnetic field by reducing the sensitivity of peripheral receptors, which causes an analgesic effect, and improving the function of conductivity, which has a positive effect on restoring the functions of injured peripheral nerve endings by improving axonal growth, myelination and inhibition the connective tissue formation in them [5, 12]. The analgesic effect of magnetic therapy is caused by increased secretion of endogenous opioids, which lead to muscle relaxant, anti-edematous and anti-inflammatory action. The use of MLT allowed to increase the effectiveness of complex treatment, optimizing the use of drugs by reducing the number of drugs and their doses, to reduce postoperative rehabilitation periods for patients with zygomatic bone fractures and can be recommended for wide use in practical medicine.

CONCLUSIONS

Thus, having analyzed the dynamics of patients' complaints as well as the objective data, pain scale indices and electrical excitability of the infraorbital nerve damage following zygomatic fractures, the use of MLT in combined therapy was found to accelerate the reduce of pain, significantly decrease the severity of all neuropathy manifestations, improve the recovery of infraorbital nerve sensory changes, increase the effectiveness of treatment and provide rapid postoperative rehabilitation of patients.

References

1. Noor M, Ishaq Y, Anwar MA. Frequency of infra-orbital nerve injury after a zygomaticomaxillary complex fracture and its functional recovery after open reduction and internal fixation. Int Surg J.2017;4:685-689. doi: 10.18203/2349-2902.isj20170214.
2. Das AK, Bandopadhyay M, Chattopadhyay A et al. Clinical Evaluation of Neurosensory Changes in the Infraorbital Nerve Following Surgical Management of Zygomatico-Maxillary Complex Fractures. J Clin Diagn Res. 2015;9(12):ZC54-ZC58. doi:10.7860/JCDR/2015/16511.7008.
3. Kaukola L, Snäll J, Roine R et al. Health-related quality of life of patients with zygomatic fracture. Med Oral Patol Oral Cir Bucal. 2017;22(5):e636-e642. doi: 10.4317/medoral.21914.
4. Gadzhula NG, Shinkaruk-Dykovytska MM, Cherepakha OL et al. Efficiency of using the diode laser in the treatment of periodontal inflammatory diseases. Wiad Lek. 2020;73(5):841-845. doi: 10.36740/WLek202005101.
5. Gagik H, Yesayan L, Seyranyan A, Matevosyan D. The use of magnetic-laser therapy of patients with post-dental implant neuropathy. JNPPR. 2020;7(1):009-112. doi: 10.17352/2455-5487.000068.
6. Rosso MPO, Buchaim DV, Kawano N et al. Photobiomodulation Therapy (PBMT) in Peripheral Nerve Regeneration: A Systematic Review. Bioengineering (Basel). 2018;5(2):44. doi: 10.3390/bioengineering5020044.
7. Horlenko IM, Gadzhula NG, Cherepakha OL et al. Clinical and microbiological assessment of root canal decontamination in chronic apical periodontitis using the ultrasound. Wiad Lek. 2020;73(6):1119-1123. doi: 10.36740/WLek202006107.
8. Nofel R, Yasser IS, Waleed TM. Rehabilitation of neurosensory changes in the infraorbital nerve following zygomatic fractures. Curr Sci Int. 2014;3:51-64.
9. Tabrizi R, Neamati M, Rajabloo S, Latifi F. Does the Lag Time Between Injury and Treatment Affect Recovery of Infraorbital Nerve Disturbances in Zygomaticomaxillary Complex Fractures? Craniomaxillofac Trauma Reconstr. 2020;13(2):105-108. doi: 10.1177/1943387520902896.
10. Furman RL, Barilo AS, Polishchuk SS et al. Treatment of pain syndrome in patients with mandible fractures by means of restorative therapy. World of Medicine and Biology. 2018;4(66):222-226. doi: 10.26724/2079-8334-2018-4-66-222-226.
11. Hong WT, Choi J., Kim JH et al. Trigeminal somatosensory evoked potential test as an evaluation tool for infraorbital nerve damage. Arch Craniofac Surg. 2019;20:223-227. doi: 10.7181/acfs.2019.00234.
12. Lee SY, Kim SH, Hwang JH, Kim KS. Sensory recovery after infraorbital nerve avulsion injury. Arch Craniofac Surg. 2020;21(4):244-248. doi:10.7181/acfs.2020.00290.

Conflics of interest:
The Authors declare no conflict of interests

Received: 04.06.2021
Accepted: 24.08.2021

ADDRESS FOR CORRESPONDENCE:
Nataliia G. Gadzhula
National Pirogov Memorial Medical University
56 Pyrohov St., 21018 Vinnytsia, Ukraine
phone: +380977011918
e-mail: gadzhula@vnmu.edu.ua

ORCID ID and AUTHORS CONTRIBUTION
0000-0003-0016-2264 – Nataliia G. Gadzhula (A, D)
0000-0002-1778-4687 – Oleksandr S. Barylo (E, F)
0000-0003-0341-8640 – Ruslan L. Furman (B, C)
0000-0003-1183-7028 – Tetiana O. Rekun (A, C)

A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article