PHYSICAL FACTORS IN TREATING MANDIBULAR FRACTURES

N.L. Erokina[1], A.V. Lepilin[1], G.R. Bahteeva[1], A.M. Panin[2], S.B. Fishchev[3], D.A. Domenyuk[4]

[1] V.I. Razumovsky Saratov State Medical University, Saratov, Russia
[2] Moscow State University of Medicine and Dentistry, Moscow, Russia
[3] Saint-Petersburg State Pediatric Medical University, Saint-Petersburg, Russia
[4] Stavropol state medical university , Stavropol, Russia

Correspondence address:
Department of general practice dentistry and child dentistry, Stavropol state medical university of Ministry of healthcare, 310, Mira Street, Stavropol, Russia 355017. E-mail: domenyukda@mail.ru, tel: +7(918)870-1205

ABSTRACT — Physiotherapy employed to treat lower jaw fractures helps improve the blood supply and innervation at the fracture area, also reducing periodontal tissues inflammation, which results in a lower likelihood of developing respective complications.

KEYWORDS — fracture, mandible, physiotherapy, periodontal issues, disturbed blood supply, neurotrophic disturbances.

INTRODUCTION

The number of complications in mandibular fractures remains high even despite newer and more efficient treatment methods [2, 3, 8, 12, 16, 17, 18, 24, 25]. Mandibular fracture complications are largely due to issues affecting the local and general blood circulation, innervation, odontogenic infection foci at the fracture spot, etc. [4,13]. The recent decades have been witnessing an increasing use of physiotherapy in treating patients with various pathologies [6, 7, 11, 14, 19, 20, 21, 22, 23], which can be accounted for by the advanced devices and methods that are available now to deliver this type of treatment, as well as by an increase in allergic responses to medications. Our studies revealed high efficiency of physiotherapy methods applied to mandibular fracture cases in order to prevent and treat complications [2, 3, 8, 9, 12, 16].

Aim of study:
to identify the efficiency of physiotherapy in preventing and treating mandibular fractures complications.

MATERIALS AND METHODS

The study involved patients with mandibular fractures who were staying at the Maxillofacial Department of Municipal Hospital #9 of the City of Saratov (Russia) and undergoing treatment involving various types of physiotherapy. The treatment implied using the ATOS, AMO-ATOS-E, Magnetic Sympathocor, Miovolna physiotherapy devices. Apart from the conventional clinical methods, the mandibular artery blood flow was studied as well as assessment carried out for the autonomic nervous system activity, neurotrophic issues at the trigeminal nerve supply, and for periodontal tissues.

DISCUSSION

While treating the 85 patients with mandibular fractures at the angle and body, we used the effect of the travelling alternating magnetic field (TAMF) of the ATOS device with a frequency of 10 Hz. Each daily session was 20 minutes with an entire course of 8–10 sessions. The control group included 15 patients whose treatment implied using the Polyus-1 device (the alternating magnetic field (AMF) induction of 20 mT), and another 15 patients, whose treatment was based on using the UHF-80 device (power — 40 W). All the patients underwent rheographic examination of the mandibular artery through the treatment.

The rheography performed after 9–11 days revealed that the blood circulation recovery in the mandibular artery was significantly speedier in case of using TAMF (the ATOS device), compared to the effect of the UHF field and the AMF of the Polyus 1 Device. So, when exposed to TAMF of 10 Hz, the rheographic index (RI) went up from 0.052±0.0077 to 0.092±0.015 ($p < 0.05$). During that, the treatment with the AMF of the Polyus-1 device resulted in an insignificant RI increase, while the course of the UHF therapy produced a higher RI increase if matched against AMF yet it was less significant compared to the TAMF effect. When using TAMF to treat patients with mandibular fractures, the rheogram amplitude increased from 2.67±0.36 to 4.25±0.73. Under the AMF influence wrought by the Polyus-1 device, the amplitude did not change significantly; UHF therapy caused a significant increase in the rheogram amplitude yet it was still lower than that from the TAMF effect. A visual analysis of the rheograms from the TAMF treatment confirmed the quantitative analysis data. The rheographic curve on the injure side was approaching the correct shape, with a pointed tip. The incisure was shifting towards the rheogram base, while there was also an emerging dicrotic wave observed.

Recovery of the blood supply delivered to the tissues at the fracture spot is one of the major factors determining the positive effect TAMF has on reparative osteogenesis. The use of the TAMF device (ATOS) helped bring down to 6% the number of patients with mandibular fractures at the body and the angle, who developed chronic traumatic osteomyelitis (vs. 13% in the comparison group).

Since a mandibular fracture is considered a stressful impact it causes significant changes in the autonomic nervous system functioning. This manifests itself through an increase in the sympathetic link activity, which is reflected in the cardiovascular system, and leads to general and regional blood circulation issues. As for the patients with mandibular fractures accompanied with an extreme degree of sympathicotonia, then the comprehensive treatment aimed at improving their autonomic nervous system activity included traveling pulsed magnetic field (TPMF) in the upper sympathetic cervical ganglia projection on both sides, which allowed periodical blockage of the ganglia activity with TPMF through the self-induction. The treatment course implied using the AMO-ATOS magnetic therapy device as well as the Magnetic Sympathocor traveling magnetic field emitter. The TPMF exposure mode was as follows: 60 mT induction, frequency 1 Hz – in the first two days; frequency 5 Hz – on Days 3 and 4; frequency 10 Hz – on Days 5 and 6. The physiotherapy sessions were held daily for 15–20 minutes [5, 15]. The patients were examined on Day 7 into the treatment.

Our method used as a part of the comprehensive treatment for 40 cases with mandibular fractures, allowed a quick arrival at the patients' vegetative status equilibrium. This was to be seen from the data reflecting the heart rate, blood pressure, vegetative Kerdo index, Hildebrant index, the eyeball-heart and the epigastric reflexes, orthostatic and clinostatic tests, the Baevsky-method based cardiointervalography [1] as well as the catecholamine blood levels. According to rheovasography, the autonomic nervous system improvement could be also observed through the recovered regional blood flow in the lower alveolar artery, evidence to that being a decrease in V_{max} (reflects improved blood flow in the systole) and V_{min} (reflects a significantly improved blood flow in the diastole; depends on the vascular walls tone). At the same time, the V_{min} values (7.3 [3.4–16]) differed significantly from similar values in the comparison group (15.2 [8–18.8]) and approached the normal range. The blood flow recovery in the lower jaw came along with shorter local symptoms relief time (pain, swelling) and normalization of the body temperature. At the same time, mandibular fractures complications, in cases where magnetic therapy was used in the cervical sympathetic ganglia region, were observed in 5% of the cases only (during conventional treatment — in 16.3% of patients). There was no chronic issue development registered, whereas 6.7% of those receiving conventional treatment developed a subsequent transition from inflammation to chronic traumatic osteomyelitis.

A fractured mandible entails an injury of the inferior alveolar nerve which causes neurotrophic disorders, standing behind fracture complications. According to our data, 78% of the cases revealing complicated mandibular fractures had the trigeminal nerve affected. In order to correct neurotrophic disorders, 66 patients with complicated and uncomplicated mandibular fractures underwent treatment with the Miovolna (electrostimulator analgesic) device as part of the entire comprehensive treatment they were offered. The device was used following our special method [10] 7–15 minutes per day at the fracture spot, as well as distally (at the foramen mentale), and, if necessary, with an intraoral electrode. The voltage amplitude range was 15.2–17.6 V; the current frequency 6.4–10.0 Hz. The amplitude was brought up daily by 0.3–0.5 V; the entire course included 3–10 sessions.

Using this method of physiotherapy offered a significant analgesic effect. On Day 10 of electrical neurostimulation (ENS), the pain intensity in all the patients having fractures with no sensory-paresthetic issues was (average on a scale) minimal and measured next to the no pain mark (0 points), while during the conventional treatment the same value was the level of moderate pain (2±0.12 points). Patients with complicated fractures with hypoesthesia symptoms, had the pain intensity indicators not exceeding 2±0.12 points (moderate pain), whereas a similar factor in the comparison group reached the level of severe pain (3±0.16 points). After the ENS, the need for analgesics decreased significantly, and a pronounced lasting pain-relieving effect was observed (excellent and good results), whereas in the comparison group patients, pain sensations lasted in 87% cases. Sensory paresthetic disorders following the ENS featured a 17% decrease in the area and in the severity of the skin numbness in the lower lip as well as in the chin (compared with the status as of the admission date). On Day 10 after the ENS, the uncomplicated fracture cases, the average EOD (electroodontodiagnosis) value for the teeth located in the fracture gap was 56.5±4.92 CU, while the neighboring teeth had it back to normal (52±2.91

CU). That means that the excitability threshold following the physiotherapy was significantly lower (by 23%) than a similar index after the conventional treatment and fell within normal limits. After the electrical neurostimulation, the average electrical excitability indices in the cases with complicated fractures were 65.3±3.57 CU, which was much below (4 times as low) than in case of using the conventional treatment. The electrophysiological parameters got back to normal, which could be seen from the ENMG data as well as from the trigeminal SSEP registration. Physiotherapy promoted consolidation of the mandible fragments. A densitometry test performed at the fracture area a month after the injury revealed that the optical density index was I = 0.96±0.06, which reflects a better consolidation rate of bone fragments if matched against the conventional types of treatment (I = 0.84±0.07).

Given the above, nerve fibers electrical stimulation used within comprehensive treatment for mandibular fractures, leads to correction of neurotrophic issues, which brings back to the norm all the types of sensitivity, reduces the pain duration and intensity after the injury, and increases the rate of bone fragments consolidation.

Having determined the role of inflammatory periodontal diseases in the development of mandibular fracture complications (soft tissues suppuration, bone wounds, traumatic osteomyelitis) when treating patients with fractures accompanied with periodontal diseases, we used comprehensive therapy in 80 cases. That included physiotherapy procedures focusing on periodontal tissue and using the AMO-ATOS-E device on a daily basis, with the entire course including 8–10 sessions combined with treating periodontal pockets with the Cycloferon liniment. The dynamic magnetic therapy (DMT) was performed with the magnetic field rotatining alternately in opposite directions with a 1.0–1.5 min rotation exposure as per each direction, the frequency of rotation being 10 Hz. The transcutaneous electrical neurostimulation (TENS) was performed at a voltage amplitude ranging from 15.2 to 17.6 V, where the current frequency was 6.4–10.0 Hz.

Using combined effects on periodontal tissue in patients with mandibular fractures allowed reducing the severity of inflammatory and destructive processes affecting periodontal tissues by the time of removing the splint. This could be seen from the periodontal indices: the mean PMA index value was 29.8±1.1 (vs. 48.5±1.4 in the comparison group), PI – 1.8±0.12 (2.9±0.09 in the comparison group). The improved blood circulation in the periodontal tissues reflected the level of tissue perfusion studied via laser Doppler flowmetry. After the treatment, it was 0.304±0.009 (vs. 0.223±0.014 in the comparison group). The comprehensive treatment entailed an improved level of cytokines in the periodontal pockets, which manifested itself through a decrease in the levels of pro-inflammatory cytokines IL-1ß, IL-8, TNFα, γ-INF (these indices were significantly lower compared to the patients who received conventional treatment), and an increase in the anti-inflammatory cytokine IL-4 level, which was significantly higher compared to the same factor at admission, and in case of the conventional treatment. The cytomorphological studies also reflected the immune response activation and the absence of the inflammatory and destructive progress in the periodontal tissues.

The relief of periodontal tissue inflammation in patients with mandibular fractures combined with gingivitis and periodontitis reduced the number of respective complications. Comprehensive therapy offered to patients with periodontal inflammation issues, for instance, led to a decrease in the number of mandibular fracture complications bringing them down almost 2 times compared with patients who were given the conventional orthopedic treatment.

CONCLUSION

Physiotherapy methods that exercise a beneficial effect on tissues blood supply and innervation can be employed to treat patients with fractured mandibles both to prevent and to treat complications. The said treatment allows reducing the pain intensity and duration as well as bringing down the rate of complications in fractured mandible cases.

REFERENCES

1. **Baevskij, R. M., Kirillov O.I., Kleckin S.Z.** Mathematical analysis of changes in heart rate under stress. M.: Nauka, 1984. – 221 s.
2. **Bahteeva G.R.** Features of the course and treatment of fractures of the lower jaw, accompanied by damage to the third branch of the trigeminal nerve: Diss.. – Volgograd., 2010. –24 s. (In Russ.).
3. **Erokina N.L.** Modern methods of examination and substantiation of pathogenetic treatment of inflammatory periodontal diseases in patients with fractures of the mandible: Diss. – Volgograd, 2009. – 38 s. (In Russ.).
4. **Erokina N.L., Lepilin A.V., Zaharova N.B., Rogatina T.V., Lyapina YA.A., Prokof'eva O.V., Lukashov V.A.** The Use of cytological studies of periodontal pockets of periodontitis patients with fractures of the mandible to select the method of immobilization. Saratovskij nauchno-medicinskij zhurnal. 2011 – T.7, № 4 –S. 905–909. (In Russ.).

5. **Erokina N.L., Lepilin A.V., Prokof'eva O.V., Rogatina T.V., Sojher M.G., ZHilkina O.V.** Way of correction of vegetative disorders in patients with mandibular fractures. Saratovskij nauchno-medicinskij zhurnal. - Izd-vo SGMU. – 2012. - №2. – S. 424 – 428. (In Russ.).
6. **Kirichuk V.F., Lepilin A.V., Apal'kov I.P., Erokina N.L.** Microcirculatory disorders in patients with chronic generalized periodontitis and their correction by EHF therapy. Byulleten' sibirskoj mediciny. 2003. № 2. S. 99. (In Russ.).
7. **Kirichuk V.F., SHirokov V.YU., Erokina N.L., Goloseev S.G., Govorunova T.V.** Microcirculatory link of the hemostatic system in patients with chronic generalized periodontitis in combination with diseases of the gastroduodenal region and its dynamics in combined EHF therapy. Parodontologiya. 2005. № 1. S. 21–25. (In Russ.).
8. **Lepilin A.V.** Prevention and pathogenetic treatment of purulent infectious complications of traumatic injuries of the bones of the face: Diss. M.: MMSI im. N.A. Semashko, 1995. – 43 s. (In Russ.).
9. **Lepilin A.V., Rajgorodskij YU.M., Nozdrachev V.G., Erokina N.L.** Dynamic magnetotherapy in the complex treatment of phlegmon of the maxillofacial region and mandible fractures. Stomatologiya. 2007. T. 86. №5. S. 55–57. (In Russ.).
10. **Lepilin A.V., Erokina N.L., SHolomov I.I., Bahteeva G.R.** A Method of treating damage to the lower alveolar nerve in the mandibular fractures. Patent for invention RUS 2332245 09.04.2007. (In Russ.).
11. **Lepilin A.V., Rajgorodskij YU.M., Ostrovskaya L.YU. Erokina N.L., Konnov V.V., CHadina T.V.** Application dental complex CAP -"PERIODONTIST" in the treatment of periodontal disease. Stomatologiya. 2008. № 5. S. 39. (In Russ.).
12. **Lepilin A.V., Erokina N.L.** Optimization of treatment of patients with mandibular fractures in combination with inflammatory periodontal disease. Dental YUg. 2008. № 10. S. 28. (In Russ.).
13. **Lepilin A.V., Erokina N.L., Titorenko V.A., Ostrovskaya L.YU., Bisultanov H.U.** Periodontal Status of patients with mandibular fractures in combination with inflammatory diseases of periodontium in dynamics of treatment. Saratovskij nauchno-medicinskij zhurnal. 2008. T. 4. №1. S. 115–118. (In Russ.).
14. **Lepilin A.V., Rajgorodskij YU.M., Erokina N.L., Rogatina T.V., Lyapina YA.A., Lukashov V.A.** The Influence of dynamic magnetic therapy dental complex CAP – "PERIODONTIST", percutaneous electroneurostimulation apparatus "Jovana" and the remedy "Traumeel s" on hemostasis and regional circulation in patients with inflammatory periodontal diseases in complicated fractures of the mandible. Parodontologiya. 2009. №2. S. 54–60. (In Russ.).
15. **Lepilin A.V., Erokina N.L., Rajgorodskij YU.M., Prokof'eva O.V., Bahteeva G.R., Rogatina T.V.** Method of treatment of patients with mandibular fractures. Patent for invention RUS 2481130 12. 03.2012. (In Russ.).
16. **Lepilin A.V., Erokina N.L., Fishchev S.B., Bahteeva G.R., Rogatina T.V.** Analysis of the causes of complications of mandibular fractures. Parodontologiya. 2017. T. 22. №3. S. 60-63 (In Russ.).
17. **Bouchard C.** Open Reduction with Internal Fixation of Mandibular Angle Fractures: A Retrospective Study. M. Mansouri //J Can Dent Assoc.- 2017 Jan;82:h3.
18. **Radabaugh J.P., Horn A.V., Chan S.A.** Patient compliance following isolated mandibular fracture repair. Laryngoscope. – 2017/ Mar 21. doi: 10.1002/lary.26556.
19. **Kulikova, N.G.** Evaluation of the effectiveness of pharmaco-physiotherapeutic treatment of catarrhal gingivitis on the results of the condition of mucosal immunity of oral cavity in women in the postpartum period / N.G. Kulikova, D.A. Domenyuk, V.A. Zelensky, A.S. Tkachenko // Medical news of North Caucasus. 2017. – Vol. 12. – № 4. – P. 417–421. (In Russ., English abstract). DOI: 10.14300/mnnc.2017.12117.
20. **Agarkov, N. M.** Mathematical prediction of phlegmon development in acute odontogenic osteomyelitis of jaws in terms of blood and systemic immunity / N.M. Agarkov, S.N. Gontarev, D.A. Domenyuk, V.A. Zelensky, K.F. Makkonen, E.P. Afanasova, A.V. Ivanov, T.I. Subbotina // Medical news of North Caucasus. 2018. – Vol. 13. – № 1-1. – P. 62–65. (In Russ., English abstract). DOI: 10.14300/mnnc.2018.13018.
21. **Domenyuk D.A., Gilmiyarova F.N., Vedeshina E.G., Ivchenko L.G.** The diagnostic significance of the clinical functional and immunological studies in assessing the effectiveness of complex therapy of chronic gingivitis (Part I). The Dental Institute. 2017; 74(1): 46–47. (In Russ.)].
22. **Domenyuk D.A., Gilmiyarova F.N., Vedeshina E.G., Ivchenko L.G.** The diagnostic significance of the clinical functional and immunological studies in assessing the effectiveness of complex therapy of chronic gingivitis (Part II). The Dental Institute. 2017; 75(2): 30–33. (In Russ.)].
23. **Domenyuk D.A., Gilmiyarova F.N., Vedeshina E.G., Ivchenko L.G.** Use of low-intensive laser therapy in the complex treatment of generalized cataral gingivitis in women. Periodontology. 2017; Vol. XXII; 1 (82): 45–51. (In Russ.)].
24. **Karpov S. M., Gandylyan K. S., Karakov K. G., Zelenskiy V. A., Porfiriadis M. P., Khachaturyan E. E., Domenyuk D. A., Chalaya E. N.** Maxillofacial trauma as the cause of neurophysiological CNS disorder. Medical news of North Caucasus. 2015. – Vol. 10. – № 4. – P. 361–365. (In Russ., English abstract). DOI – http://dx.doi.org/10.14300/mnnc.2015.10088

25. **Gandylyan K. S., Karpov S. M., Romanenko I. S., Karakov K. G., Zelenskiy V. A., Porfiriadis M. P., Khachaturyan E. E., Domenyuk D. A., Chalaya E. N.** During different clinical forms of acute odontogenic inflammatory diseases. Medical news of North Caucasus. 2015. – Vol. 10. – № 4. – P. 394–398. (In Russ., English abstract). DOI: 10.14300/mnnc.2015.10096