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ANATOMICAL AND CLINICAL JUSTIFICATION OF THE MODIFICATION OF MANDIBULAR ANESTHESIA IN THE BACK LOW BLOCK TECHNIQUE

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The study was dedicated to the improvement of the safety and effectiveness of conduction anesthesia on the mandible using an alternative method of mandibular anesthesia with appropriate anatomical justification and further testing of its clinical effectiveness. The anthropometric parameters of 91 dry anatomical preparations of the adult mandible were studied. Clinical observations were conducted in 440 patients aged 18 to 65 years. A total of 220 anesthetizations were performed using the traditional Inferior Alveolar Block technique and 220 anesthetizations using the Back Low Block technique for the treatment of caries and its complications. According to the results of a comparative evaluation of mandibular anesthesia using the traditional and the proposed methods with the use of standard anesthetic, a greater effectiveness of anesthesia in the Back Low Block technique was proved, as evidenced by an increase in the index of local anesthesia.

Key words: anesthesia, lower jaw, anatomy, inferior alveolar nerve, mandibular canal, clinical effectiveness, tomography.

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АНАТОМО-КЛІНІЧНЕ ОБҐРУНТУВАННЯ МОДИФІКАЦІЇ МАНДІБУЛЯРНОЇ АНЕСТЕЗІЇ В ТЕХНИЦІ BACK LOW BLOCK

Дослідження було присвячене підвищенню безпеки та ефективності провідникової анестезії на нижній щелепі за допомогою альтернативної методики мандібулярної анестезії з відповідним анатомічним обґрунтуванням та подальшою перевіркою її клінічної ефективності. Було вивчено антропометричні показники 91 сухих анатомічних препаратів нижньої щелепи дорослих. Клінічні спостереження проводились у 440 пацієнтів віком від 18 до 65 років. Усього було проведено 220 анестезій за традиційною методикою Inferior Alveolar Block та 220 анестезій за методикою Back Low Block при лікуванні карієсу та його ускладнень. За результатами порівняльної оцінки мандібулярної анестезії за традиційною та за запропонованою методиками з використанням стандартного анестетику доведено більшу ефективність анестезії в техниці Back Low Block, про що свідчить збільшення індексу місцевої анестезії.

Ключові слова: анестезія, нижня щелепа, анатомія, нижньоальвеолярний нерв, нижньощелепний канал, клінічна ефективність, томографія.

The work is a fragment of the research project "Improving the effectiveness and safety of analgesia in the treatment of dental patients and features of its implementation in somatic pathology", state registration No. 0122U000042.

As of today, in dentistry, conductive anesthesia is most often used to perform various types of treatment on the lower jaw [3, 4, 9]. There are many options for performing mandibular anesthesia, both intraoral and extraoral [6, 7, 8, 10]. Extraoral methods are rarely used today, preference is given to intraoral methods, of which the most common is Inferior Alveolar Block [2, 7, 10]. This technique has a number of significant drawbacks related to its effectiveness and safety. It is known that some of the factors that reduce the effectiveness of this method depend on the correctness of the manipulation by the doctor, and the other part is associated with anatomical and individual characteristics [2, 9].

The anatomy of the maxillofacial region is extremely complex. There are many structures in a small space that form complex anatomical complexes and spaces. Understanding the structure of this area and the ability to navigate is a mandatory skill when performing any interventions. In particular, the effectiveness and safety of conduction anesthesia on the mandible is directly determined by the influence of anatomy [2, 8].

An anatomical study of the area of this target point identified a number of features that can directly affect the effectiveness and safety of anesthesia [8]. Among these features, there are two most significant ones. The first is the direct location of the target nerves (inferior alveolar, lingual, and buccal), and the second is the influence of anatomical structures on the distribution of the anesthetic solution. Understanding the peculiarities of the position of the target nerves, especially the inferior alveolar and lingual nerves, as well as the inferior alveolar branch of the maxillary artery, is of great clinical importance [2]. A preliminary anatomical study showed that contrary to the common beliefs among dentists about the structure of this area, the inferior alveolar nerve and the corresponding artery are not in contact with the bone before entering the mandibular canal, but approach the mandibular foramen at an angle of about 45 degrees. Similarly, the lingual nerve is located, which is pressed against the bone at the level of the mandibular foramen, somewhat more medially, and then runs along the inner surface of the mandible [2]. Therefore, when performing mandibular anesthesia, injury to the vessel and nerve is possible when the needle is advanced to contact with the bone, and intravascular injection – when the artery is targeted, which, in the presence of contact with the bone, can occur only at the point of its entry into the funnel region of the mandibular canal, i.e. the risk of injury to blood vessels and nerves is significantly foreseen by the technique itself.

An important condition for successful conduction anesthesia is the creation of a sufficient concentration of anesthetic solution in the immediate vicinity of the nerve. Visualization of the anesthetic solution distribution allowed us to experiment with changing the target anesthetic site and consider the possibility of a more anatomically safe location of the target anesthetic site, where the needle direction would not cross the course of the target nerves and corresponding vessels, which can significantly reduce the risk of local complications.

The purpose of the study was to improve the safety and efficacy of conduction anesthesia in the mandible using an alternative mandibular anesthesia technique with appropriate anatomical justification and further testing of its clinical effectiveness.

Materials and methods. The anatomical part of the study was conducted at the Department of Normal and Pathological Clinical Anatomy of Odesa National Medical University (ONMedU). In alignment with bioethical standards, all procedures were meticulously planned to ensure respect for the dignity and integrity of anatomical donations. The anthropometric parameters of 91 dry anatomical preparations of the mandible of adults were studied. The structure of the target points of mandibular anesthesia was studied on 21 sagittal sections of the human head. A series of anatomical dissections were performed by filling the studied anatomical area with staining and self-hardening solutions. The analysis of variants of anatomical norm and the distribution of the infusion solution in the corresponding anatomical area was performed by computed tomography. Computed tomography with "Verografin" contrast agent was performed on 4 sagittal sections of the human head on a Toshiba Aquillion 64 tomograph.

Clinical observations were conducted on 440 patients aged 18 to 65 years who underwent dental treatment at the SE "The Institute of stomatology and maxillofacial surgery of the National academy of medical sciences of Ukraine" and the Department of General Dentistry of ONMedU. In total, 220 anesthetizations were performed using the traditional Inferior Alveolar Block (IAB) technique and 220 anesthetizations using the Back Low Block (BLB) technique for the treatment of caries and its complications. For local anesthesia, 4 % "Artifrin-Zdorovye" (LLC Pharmaceutical Company "Zdorovye", Ukraine) was used, 1.7 ml carpules (active ingredient: Artikain). Patient participation in this dissertation study was based on written consent. Only medicines registered in Ukraine were used. The study was conducted while maintaining the confidentiality of personal information about patients.

Method of Back Low Block mandibular anesthesia: the needle was inserted behind the alveolar part of the lower jaw at the level of the Back Low (BL) point at an angle of about 45–50 degrees to the center line. The direction of the needle was along the tangential line of the BL point. If there were teeth on the opposite side, the syringe was placed between the 5th and 6th teeth. The needle was guided to the target point in a horizontal plane and passed about 20–25 mm in contact with the bone during the entire injection time. When contact with the bone was reached, an aspiration test was performed, after which the anesthetic solution was injected if the result was negative.

The effectiveness of anesthesia was assessed using subjective and objective signs of tissue desensitization within the anesthesia, electroodontodiagnostics (EOD), the index of local anesthesia (ILA) [2].

The index of local anesthesia was calculated using the following formula: $ILA=(CExTI)\div V$

ILA – index of local anesthesia, conventional units

CE – clinical efficacy of anesthesia, points

TI – therapeutic index of the anesthetic agent

V – volume of anesthetic solution, ml (Table 1).

Statistical processing of the material was performed by the method of mathematical statistics to analyze the obtained data, using the parametric Student's t-criterion. Verification of the found differences was analyzed at the significance level of $p<0.05$ [1].

Results of the study and their discussion. During a series of anatomical dissections with filling of this anatomical area with staining and self-hardening solutions in different sagittal sections of the human head, attention was drawn to the area located 5–10 mm below the funnel part of the mandibular canal, i.e. in the lower part of the wing-mandibular space. This area is tightly bounded by the visceral fascia of the face, the lateral wing muscle, and the fibers of the intercostal fascia spurs that loosen downward. This made it possible to imagine the guiding role of this anatomical space in the spread of solutions. It was found that the solutions were directed upward, primarily filling the space around the inferior alveolar and lingual nerves. When applying methylene blue to the inner wall of the mandibular canal in the funnel area, staining of the mandibular nerve was observed due to the diffusion of the solution through the thin cortical plate, and during decortication of the corresponding part of the mandibular canal, it was seen that the nerve was quite well stained from the periphery (Fig. 1).

Table 1

Scheme of clinical evaluation of the effectiveness of mandibular anesthesia (CE)

Anesthesia sign	Objective criterion	Points
Lip numbness	Pain when clamping the lip with tweezers between the midline and corner of the mouth	1
	No pain when clamped with tweezers, there is tactile sensitivity	3
	Pronounced asymmetry, absence of any pain sensitivity, weak tactile sensitivity	4
Numbness of the tongue and lingual surface of the gums	Pain when clamping the lateral surface of the tongue with tweezers, pain when pricking the lingual surface of the gums with a probe	1
	No pain when clamping the lateral surface of the tongue with tweezers and pain when pricking the lingual surface of the gums with a probe, weak tactile sensitivity	3
Numbness of the teeth	No difference in EOD before and after anesthesia, comparative percussion is negative, pain when exposed to cold stimuli, pain during the preparation of hard tissues of the teeth	1
	The difference in EOD values before and after anesthesia does not exceed three times, comparative percussion is positive, but not pronounced; moderate pain when exposed to cold stimuli; moderate pain during the preparation of hard tissues of the teeth, aggravated when approaching the pulp	3
	After anesthesia, EOD is not determined, there is no pain reaction to stimuli; preparation of hard tissues of teeth and opening of the pulp chamber is painless; a weak short-term pain reaction is possible when removing the root pulp, which does not affect the course of treatment and the patient's condition	8

The anatomical experiment was similar to the one performed previously for the IAB technique [1]. The same amount of radiopaque contrast agent was injected into whole sagittal sections of the human head in the area of the target point we defined.

The injection of a retrograde contrast agent allows visualization of clear contours of the wing-mandibular space, intercostal space, as well as medial and lateral wing muscles. It is in the wing-mandibular space and the interwing space that the injected solution is mainly deposited, where the target nerves pass, to the outer base of the skull in the area of the subcranial fossa.

A sufficiently compact and dense filling of these anatomical spaces contributes to a higher concentration of the solution in the area of the inferior alveolar nerve and creates conditions for its better exposure to the target nerve.

A small amount of solution is also noted posteriorly in the direction of the wing-mandibular fissure. However, the tomogram does not show the presence of contrast in the periosteal space. The position of the needle at the proposed target site is shown in Fig. 2.

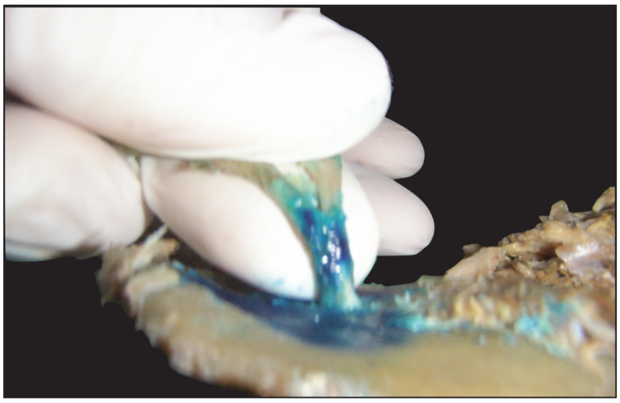

Fig. 1. Staining of the inferior alveolar nerve during dye diffusion through the inner wall of the mandibular canal.

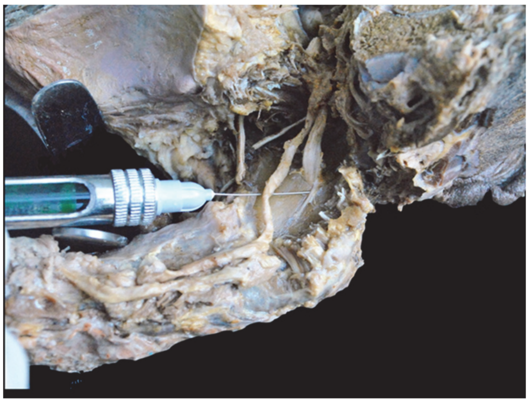

Fig. 2. Needle position at the proposed target point of mandibular anesthesia, located in the lower part of the wing-mandibular space.

A clinically important feature of the proposed target point is its location in the lower part of the wing-mandibular space, which can be considered a more anatomically safe area due to the absence of large vessels and nerves. This implies a reduced risk of local anesthetic complications.

In order to realize the advantages of the target location clinically, it became necessary to develop and clinically test a new technique of conductive anesthesia on the mandible. Based on the peculiarities of the location of the target point (distally and below) and the expected ways to achieve it during this anesthesia, the working name "Back Low Block" (BLB) was chosen.

The primary task of developing the methodology for conducting conduction anesthesia was to determine a stable reference point in the oral cavity. This reference point should be easy to determine and not dependent on the presence of teeth or the degree of mandibular atrophy. As such a reference point, we


Fig. 3. Determining the BL point on a clinical example.

chose the point at the transition of the alveolar part into the body of the mandible from the inside – point BL. Clinically, the point is located at the top of the internal oblique line, and in the horizontal plane corresponds to the level of the lower border of the funnel region of the mandibular canal and is easily determined, since it is covered with a layer of attached gum and is located at the transition to the soft tissues of the periosteal region. This makes it easy to visually or palpate this reference point (Fig. 3).

The proposed methodology is a sequence of actions aimed at achieving the target anesthetic point as accurately as possible while causing minimal concomitant trauma.

Clinical observations showed that in most cases, the first signs of anesthesia were observed during the procedure and manifested as numbness of the lip on the corresponding side and/or the front teeth. After 2–5 minutes, the numbness increased and spread to the tip and lateral surface of the tongue. Numbness of all teeth on the side of anesthesia in most cases occurred within 6–8 minutes. The peak of anesthesia was noted on average after 20–25 minutes, and the plateau lasted about 40–45 minutes, after which there was a weakening of the signs of anesthesia, which completely disappeared 120–250 minutes after anesthesia. In 15 cases, there was a slower increase in numbness, which began primarily with numbness of the tongue, other signs of anesthesia were less pronounced or absent (numbness of the teeth). The duration of anesthesia signs was within the time limits. The majority of such cases were observed at the beginning of testing and can be explained not only by the variability of anatomical norms, but also by the lack of fixed operator skills. In 8 patients, there was a rapid increase in the signs of anesthesia with the peak of anesthesia reaching 2–4 minutes after the procedure, with numbness of the outer ear and the external auditory canal area. This can be explained by the guiding influence of the spurs of the intercostal fascia, which ensures the spread of the anesthetic solution from the lower part of the wing-mandibular space through the intercostal space to the area of the subtemporal fossa with further anesthesia of the branches of the auricular nerve. In these cases, signs of anesthesia were observed for longer than 170 to 250 minutes.

It was noted that tooth numbness was the last to disappear, which was explained by good saturation of the inferior alveolar nerve with anesthetic solution and the central location of the dental axons in it.

No generalized or localized complications were noted.

Volunteers who had experience with mandibular anesthesia reported less pain and discomfort during anesthesia, as well as a more rapid increase in its symptoms. Post-injection pain was mild, and in some cases not noted at all.

The proposed BLB technique's effectiveness was determined by comparing it with the more traditional IAB anesthesia on the mandible. For an objective comparison, the index of local anesthesia (ILA) was used, which takes into account the techniques' features, the amount of anesthetic substance, and its pharmacological properties. The results of the clinical study are shown in Table 2.

Table 2

Clinical efficacy of modification of mandibular anesthesia in BLB technique in comparison with traditional IAB anesthesia

Group	CE, points	RI, relative units	V, ml	IMA, conventional units	% of "capable" anesthetics with the use of 1 carpule (1.7 ml)
BLB Group	14.1±1.2	3.33	1.82±0.71	22.8±1.7	86.4 %
IAB Group	12.5±1.4 p<0.05	3.33	2.63±0.85 p<0.05	13.9±1.9 p<0.05	46.8 %

Note. p – is the index of significance of differences between studied groups.

Clinical analysis showed a significantly higher efficiency of the proposed technique. The IMA averaged 13.9 conventional units for the Inferior Alveolar Block and 22.8 points for the Back Low Block. The main factor in the difference in the IMA indicators for the anesthesia under consideration was the volume of the anesthetic solution. Thus, when performing BLB anesthesia in 86.4 % of cases (190 out of 220 patients), it was enough to use one carpool of anesthetic solution (1.7 ml) to achieve successful anesthesia, and in 13.6 % of cases, 2 carpools (3.4 ml) were used. Whereas in IAB anesthesia, one carpule was sufficient to achieve success in only 46.8 % of cases (103 out of 220 patients). In clinical trials, no generalized or local complications were noted in both groups.

Of great interest was the analysis of the clinical dynamics of anesthesia. For this purpose, its signs were recorded every two minutes and evaluated using CE scores. The conclusion about the effectiveness of the techniques was made ten minutes after the injection of the anesthetic. If during this time insufficient signs of anesthesia were noted and the patient felt pain in the tooth, the amount of local anesthetic was doubled to 3.4 ml. With the IAB anesthesia technique, about 10 % of cases were observed when additional injections had to be performed to achieve a good anesthesia, increasing the amount of anesthetic to 7 ml, as well as using other techniques. Most often, this was observed in the treatment of acute molar pulpitis, where pain persisted after pulp removal, which led to the need for intra-pulpal anesthesia. Similar situations during BLB anesthesia were rare. In all cases, after the administration of an additional dose of anesthetic, it was possible to open the tooth cavity for intra-pulpal anesthesia.

It was found that the peak of anesthesia when using the BLB technique occurred from the 12th minute, and the IAB - from the 18th minute. The plateau of anesthesia with both techniques was about 40–45 minutes, after which there was a negative dynamics of anesthesia with a gradual decrease in symptoms over 60–150 minutes and there were isolated cases of “excessively long” anesthesia, which could last up to 6–8 hours, according to patients. This can be explained both by individual metabolic characteristics and by “errors” during anesthesia, in particular, endoneural injection.

During IAB anesthesia, 9 positive aspiration samples were obtained. There were no positive aspirations during BLB.

According to the subjective feelings of patients, the injection using the IAB technique is much more painful than with BLB. Also, postinjection pain was less common with BLB, which may be explained by less concomitant trauma, since the target anesthetic point is lower than with IAB.

The anatomical basis of this research is crucial. The identified target area for BLB, situated 5–10 mm below the funnel part of the mandibular canal, is tightly bounded by critical anatomical structures, thereby reducing the risk of injury. This finding is pivotal, considering the complex anatomy of the maxillofacial region and its impact on the efficacy of conduction anesthesia. The positioning of this area aligns with earlier research that underscores the importance of understanding the intricate structures within this region for successful dental interventions [2, 8]. Clinically, the BLB method demonstrated a higher efficacy, as indicated by the increased ILA. This efficiency is attributed to a more focused deposition of the anesthetic solution around the target nerves. Furthermore, the reduced volume of anesthetic required for effective BLB anesthesia also highlights its efficiency, resonating with findings from other studies on the efficiency of dental anesthetics [5, 9]. From a clinical and patient comfort standpoint, BLB has shown promising results. Patients experienced less discomfort during and after the procedure, and there was a quicker onset of anesthesia compared to the IAB method. The comparison with the traditional IAB technique sheds light on the superiority of BLB in terms of quicker onset and duration of anesthesia. The anatomical dissections conducted in this study provide a clear visualization of the anesthetic distribution, which correlates with the reduced need for additional anesthetic in the BLB technique. This aspect of BLB is particularly noteworthy and is supported by previous research in the field [2]. In summary, the BLB technique emerges as a notably safer and more effective method for mandibular anesthesia compared to the traditional IAB technique. Its anatomical underpinning provides a substantial safety margin by minimizing the risk of nerve and vessel injury. Clinically, BLB enhances the quality of anesthesia and patient comfort, which are essential in dental procedures. Future research should focus on further refining this technique and exploring its applicability across diverse patient populations.

Conclusions

1. With the help of anatomical studies, the area located 5–10 mm below the funnel part of the mandibular canal in the lower part of the wing-mandibular space was determined to be tightly bounded by the visceral fascia of the face, the lateral wing muscle and the fibers of the spurs of the interwing fascia and is more anatomically safe, which gives grounds for its consideration as an alternative target point.

2. Injection of radiopaque substance below the funnel part of the mandibular canal leads to dense deposition of the solution in the wing-mandibular space and interwing space, where the target nerves pass towards the outer base of the skull in the area of the subcranial fossa.

3. The proposed target point in the lower part of the wing-mandibular space is more anatomically safe, due to the absence of large vessels and nerves, and also contributes to a higher concentration of the solution in the desired area of deposition.

4. The analysis of the clinical effectiveness of the proposed method of mandibular anesthesia using the Back Low Block technique showed an increase in the IMA index by 1.6 times compared to the classical Inferior Alveolar Block technique, due to increased signs of pain relief (on average by 1.6 CE points) with a decrease in the amount of anesthetic (on average by 0.8 ml).

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RELATIONSHIP BETWEEN FUNCTIONAL INDICES OF MYOCARDIAL REMODELING AND BLOOD PRESSURE IN ATHLETES WITH PREHYPERTENSION

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It was found that athletes with prehypertension have a higher parameter of left ventricular hypertrophy Romhilt-Estes index, according to other parameters (Sokolov-Lyon index, Cornell voltage index, Gubner index, Perugia index, prevalence of arrhythmias and early ventricular repolarization syndrome) no differences were found. Echocardiogram analysis revealed a significant increase of the left ventricular myocardium mass index: 103.73±18.93 g/m^2 for prehypertensive athletes and 86.70±20.55 g/m^2 for the persons with normal optimal blood pressure; p=0.012), Tei index did not differ strongly between both groups. We also found a moderate positive correlation between pulse blood pressure and Romhilt-Estes index, r = 0.745, p <0.001. The higher prevalence of dysautonomic symptoms in athletes with prehypertension and higher exercise intensity, may indicate that increased blood pressure and electrical remodeling of the myocardium in this group are manifestations of maladaptation disorders, which develops on the background of chronic nonfunctional overreaching and overtraining.
Key words: myocardial remodeling, electrocardiography, blood pressure, professional athletes, prehypertension.

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ЗВ'ЯЗОК МІЖ ФУНКЦІОНАЛЬНИМИ ПОКАЗНИКАМИ РЕМОДЕЛЮВАННЯ МІОКАРДА ТА АРТЕРІАЛЬНИМ ТИСКОМ У СПОРТСМЕНІВ З ПРЕГІПЕРТЕНЗІЄЮ

Встановлено, що у атлетів з прегіпертензією був вищим показник гіпертрофії лівого шлуночка Ромхілта-Естеса, за іншими параметрами (індекс Соколова-Лайона, Корнельський вольтажний індекс, індекс Губнера, індекс Перуджа, поширеність аритмій та синдрому ранньої реполяризації шлуночків) відмінностей встановлено не було. При цьому спостерігалося збільшення індексу маси міокарда лівого шлуночка: 103,73±18,93 г/м^2 у атлетів з прегіпертензією та 86,70±20,55 г/м^2 у осіб з оптимальними нормальними значеннями артеріального тиску (p=0,018), індекс Теі не відрізнявся значимо у обох групах. Також нами встановлено помірну позитивну кореляцію між пульсовим АТ та індексом Ромхілта-Естеса, r=0,745, p<0,001. Більша поширеність вегетативних симптомів у спортсменів з прегіпертензією та вища інтенсивність фізичних навантажень, можуть вказувати на те, що підвищення артеріального тиску та електричне ремоделювання міокарда у осіб цієї групи є проявами дезадаптаційних порушень, що розвинулися на фоні нефункціональних перенапружень та перетренованості.
Ключові слова: ремоделювання міокарда, електрокардіографія, артеріальний тиск, спортсмени-професіонали, прегіпертензія.

The study is a fragment of the research project "Physical therapy and prevention of injuries and diseases in athletes", state registration No. 0122U200927.

The main factor for professional sportsmen's success is an intensive and prolonged physical exercises practiced as training and competing activities. Although currently regular physical exercise is regarded as a leading way to prevent most widespread diseases (cardiovascular, metabolic, musculoskeletal and nervous disorders, etc.) [13], its high and often excessive level for skilled athletes can cause a range of body changes, which requires new advanced examination, diagnosing and dynamic observation [11]. In