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Оперативное лечение посттравматической нестабильности плечевого сустава у спортсменов. Артроскопическая операция Латарже или свободный костный аутотрансплантат?

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АННОТАЦИЯ

Введение. Оперативное лечение посттравматической нестабильности плечевого сустава подразумевает использование различных хирургических техник: операции Латарже, Банкарта, а также применение свободного костного аутотрансплантата. У каждого из предложенных методов есть свои преимущества и недостатки, вследствие чего в последние 10 лет развиваются методики пластики суставной поверхности лопатки.

Цель. Комплексная оценка результатов биомеханических исследований плечевого сустава в послеоперационном периоде после артроскопической операции Латарже и артроскопической стабилизации с использованием свободного костного трансплантата у профессиональных спортсменов.

Материалы и методы. За период с 2017 по 2022 год в Клинике спортивной, балетной и цирковой травмы им. З.С. Мироновой (ФГБУ «НМИЦ ТО им. Н.Н. Приорова») было выполнено 27 артроскопических операций у пациентов с посттравматической нестабильностью плечевого сустава.

Результаты. По результатам сравнительного исследования биомеханики плечевого сустава в послеоперационном периоде у 27 спортсменов, проведённого нами в научном отделе медицинской реабилитации НМИЦ ТО им. Н.Н. Приорова под руководством И.С. Косова, было выявлено, что применение артроскопической операции Латарже снижает силовые характеристики плечевого сустава, а также нарушает проприоцептивную чувствительность и, как следствие, тонкую координацию движений.

Заключение. Выбор методики хирургического лечения посттравматической нестабильности плечевого сустава у спортсменов зависит от специфики спорта. Применение свободного костного блока позволяет сохранить тонкие координированные движения, что важно в гимнастике, синхронном плавании и т.д., также свободный аутотрансплантат не снижает силовые характеристики после операции. Операцию Латарже можно использовать при командных видах спорта (баскетбол, волейбол и т.д.) без потери спортивного результата.

Ключевые слова: посттравматическая нестабильность; артроскопия плеча; операция Латарже; свободный костный блок.

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ЭКО•ВЕКТОР

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Surgical treatment of post-traumatic instability of the shoulder joint in athletes. Arthroscopic Latarjet procedure or free bone autograft?

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ABSTRACT

BACKGROUND: Surgical therapy for post-traumatic shoulder includes a variety of procedures, such as the Latarjet operation, Bankart, and the use of free bone autograft. Each of the offered approaches has advantages and disadvantages. As a result, techniques for plastic surgery of the articular surface of the scapula have been developed in the last 10 yr.

OBJECTIVE: To comprehensively evaluate the outcomes of biomechanical studies of the shoulder joint in the postoperative period after arthroscopic Latarjet operation and arthroscopic stabilization using a free bone graft in professional athletes.

MATERIALS AND METHODS: From 2017 to 2022, the Clinic for Sports, Ballet, and Circus Trauma, named after Z.S. Mironova (N.N. Priorov National Medical Research Center for Traumatology and Orthopedics), performed 27 arthroscopic procedures on patients with post-traumatic shoulder joint instability.

RESULT: According to the results of a comparative study of the biomechanics of the shoulder joint in the postoperative period in 27 athletes, conducted by us in the scientific department of medical rehabilitation of the N.N. Priorov, under the guidance of I.S. Kosov, it was revealed that the use of arthroscopic Latarjet operation reduces the strength characteristics of the shoulder joint and violates proprioceptive sensitivity, resulting to fine coordination of movements.

CONCLUSIONS: The surgical treatment of post-traumatic shoulder joint instability in athletes is determined by the sport. A free bone block allows you to maintain fine coordinated movements, which is vital in gymnastics, synchronized swimming, and other sports, and a free autograft does not reduce strength characteristics after surgery. The Latarjet operation can be used in team sports (basketball and volleyball) without affecting the outcome of the game.

Keywords: post-traumatic instability; shoulder arthroscopy; Latarjet operation; free bone block.

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ECO•VECTOR

INTRODUCTION

According to Waterman et al. (2016), shoulder instability occurs in up to 24 per 1000 athletes and is an urgent problem at the present stage. The shoulder joint has the greatest functional significance in the following high-performance sports [1–3]:

- Contact sports: wrestling, sambo, boxing, and mixed martial arts
- Team disciplines: basketball, volleyball, and handball
- Gymnastics (both sports and artistic)
- Track and field athletics: hammer, javelin, discus, and shot put

To date, many surgical techniques have been proposed for the treatment of posttraumatic shoulder instability. Each treatment method has its advantages and disadvantages. The most common surgical techniques at the present stage are as follows [4–6]:

- Bankart arthroscopic soft tissue surgery
- Latarjet–Bristow open surgery
- Latarjet–Bristow arthroscopic surgery
- Open surgery using a free bone autograft
- Arthroscopic stabilization using a bone autograft

Posttraumatic instability of the shoulder joint with bone mass loss of the scapula articular socket is considered the most difficult in terms of prognosis and treatment results. As a result, operative techniques of glenoid bone grafting have actively developed in the last decade [7–9].

This study **aimed** to comprehensively evaluate the results of the biomechanical studies of the shoulder joint in the postoperative period following arthroscopic Latarjet surgery and arthroscopic stabilization using free bone autograft in professional athletes.

MATERIALS AND METHODS

Study design

A descriptive observational study was conducted.

Inclusion criteria

The study included professional and amateur athletes with a scapular articular surface bone mass deficit of more than 20%, recurrent shoulder instability, and bone mass loss of the humeral head of more than 3×3 cm.

Terms and conditions of the event

The study was conducted at the biomechanics laboratory of the Priorov Central Institute for Trauma and Orthopedics.

Duration of the study

The study was conducted from 2017 to 2022.

Description of the medical intervention

Patients with posttraumatic shoulder instability underwent Latarjet arthroscopic surgery and arthroscopic stabilization of the shoulder joint using free bone autograft.

Ethics Committee

The study was approved by the local ethics committee on December 26, 2022 (Protocol #1).

RESULTS

Study participants

The study included professional and amateur athletes with posttraumatic shoulder instability accompanied by ⩾20% bone mass loss of the scapular socket, and participants were divided into two groups according to the type of surgical intervention performed [10–14]:

- Latarjet arthroscopic surgery
- Arthroscopic stabilization using a free bone autograft

From 2017 to 2022, 27 arthroscopic surgeries were performed on patients with posttraumatic shoulder instability at the Z.S. Mironova Clinic of Sports, Ballet and Circus Trauma (Priorov Central Institute for Trauma and Orthopedics). Latarjet arthroscopic surgery was performed in 19 (70.4%) patients. In 8 (29.6%) patients, patients underwent arthroscopic stabilization using bone autograft. The mean age of the patients was 29.4 ± 1.4 years, and there were 23 (86.9%) male and 4 (13.1%) female participants. The predominant were power sports, namely, judo (n = 12, 46.1%), sambo and mixed martial arts (n = 9, 33.3%), and rhythmic gymnastics, basketball, and javelin throwing (n = 6, 22.2%) [2, 3, 15, 16].

To date, according to Known et al., surgical treatment is indicated for all patients of active age with posttraumatic pathologies of the shoulder joint in the absence of contraindications [5, 17–20].

Arthroscopic stabilization using a free bone graft is one of the possible treatment options for patients with posttraumatic shoulder instability [21–24]. This technique involves the collection of an autograft from the iliac crest and its transposition into the anterolateral aspect of the articular surface of the scapula to fill the bone defect [5, 25, 26].

The dynamic observation and examination of our patients in the biomechanics laboratory at the Priorov Central Institute for Trauma and Orthopedics within 1.5 years following the surgical intervention revealed the following differences in the functional indices of the shoulder joint in those who underwent arthroscopic Latarjet surgery:

- Longer recovery time during the pretraining period
- Complaints of loss of athletic performance skills, i.e., muscle strength, endurance, and reaction speed (as measured by the visual analog pain scale, USES, and UCLA scale).

Shoulder biomechanics

The “hanging” shoulder joint is stabilized by passive (capsuloligamentous apparatus) and active (periarticular muscles) stabilizers. A special distinguishing feature is the need to compensate for the gravitational component [27–30].

Biokinematic chain "scapula–shoulder–forearm"

Moments of force:

- Anti-gravity
- Driving
- Internal rotation torque

In this biokinetic chain, the biceps brachii forms a force vector directed from the attachment site of the common tendon on the tuberosity of the radius to the attachment site of the short-head tendon on the clavicular process of the scapula [16, 31, 32].

In this case, the resultant forces acting from bottom to top and from outside to inside are responsible for the antigravity, driving, and torque intra-rotational moments (Fig. 1).

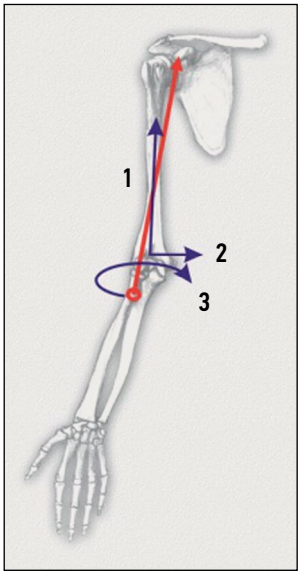

Fig. 1. Biokinematic chain "scapula–shoulder–forearm".

Receptor function of joint stabilizer muscles

The activity of the joint stabilizer muscles is regulated reflexively (Fig. 2):

- Tendon Golgi organs (receptors of the muscle tension regulation system)
- Muscle spindles (receptors of the muscle length regulation system)

The activity of the joint stabilizer muscles is regulated reflexively. The normal anatomical position of the muscle attachment points is one of the components of the normal physiological system of the biocontrol of the tonic activity of stabilizer muscles [19, 20].

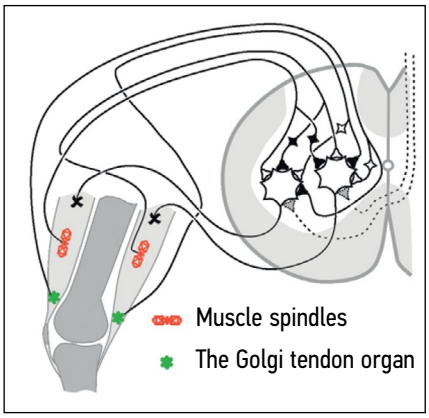

Fig. 2. The activity of joint stabilizing muscles is regulated reflexively.

Intact muscle fixation points provide physiologic length

The operative convergence of the muscle fixation points (during the transposition of the short head of the biceps in Latarjet surgery) may contribute to impaired reflex reactions and imbalance in active–dynamic stabilization of the shoulder joint, which negatively affects the recovery of sports performance (Fig. 3).

Fig. 3. Intact points of muscle fixation, ensuring its physiological length.

Humeral hardware test

To qualitatively and quantitatively assess the kinesiologic profile of shoulder dislocation, the original humeral instrumentation test was used (Figure 4). The stages of patient testing were as follows:

- Goniogram of the m. deltoideus in the lead
- Spectrogram of the m. trapezius
- Spectrogram of the m. deltoideus
- Spectrogram of the m. biceps
- Electromyogram of the m. deltoideus

A pocket EMG device uses digital goniometers to estimate the angles of withdrawal and record the voluntary bioelectrical activity of the deltoid, trapezius, and biceps muscles of the shoulder joint in concentric (withdrawal), isometric (retention), and eccentric (adduction) phases (Figs. 5–11).

Electromyography evaluation included the following:

- Shape and amplitude of the signal
- Digital spectral analysis of recordings, i.e., determination of the functional type of the muscles under study (slow and fast functional fibers) and their characteristics (Figs. 8 and 9).

After a comprehensive analysis of the kinesiologic profile of the operated upper limb, the results were compared with those of the contralateral limb.

Fig. 4. Demonstration of scapulohumeral testing using the device.

Main results of the study

The results of the comparative study of the postoperative biomechanics of the shoulder joint in 27 athletes, which was conducted in the Scientific Department of Medical Rehabilitation at the Priorov Central Institute for Trauma and Orthopedics under the direction of Kosov, were as follows:

- In patients who underwent arthroscopic Latarjet surgery, the strength characteristics of the operated limb decreased by 14.9% because of the severing

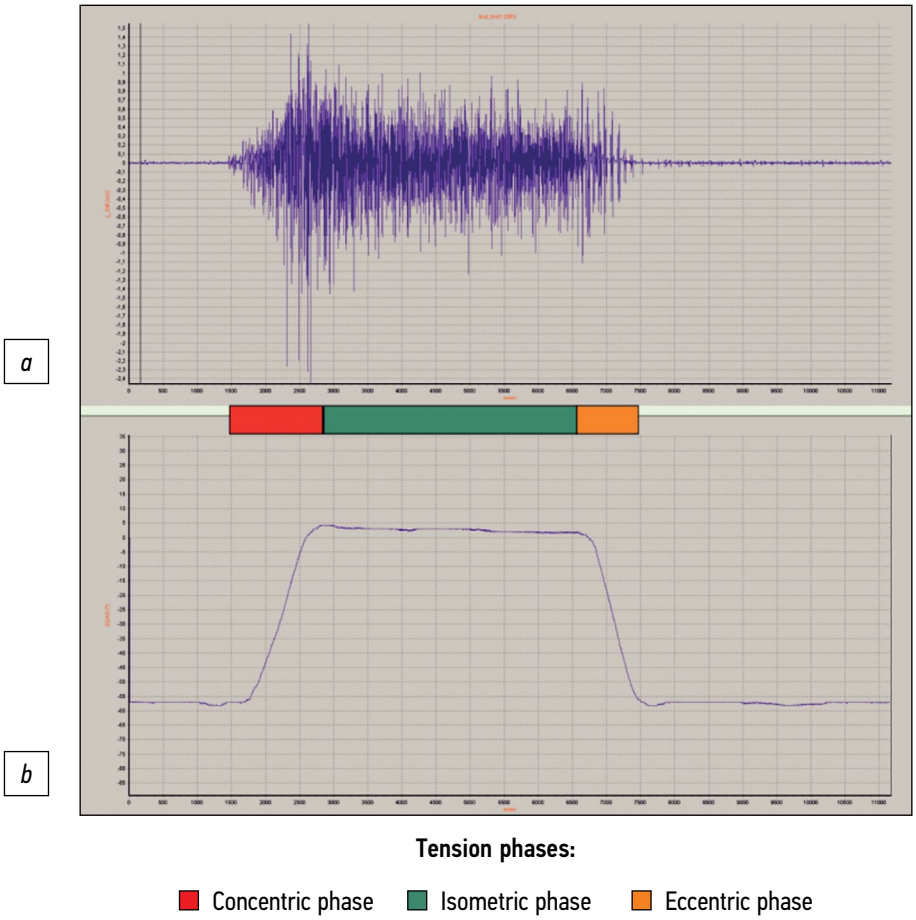

Fig. 5. An example of a protocol for processing the obtained data: *a* — electromyography of m. deltoideus, *b* — goniogram (lead).

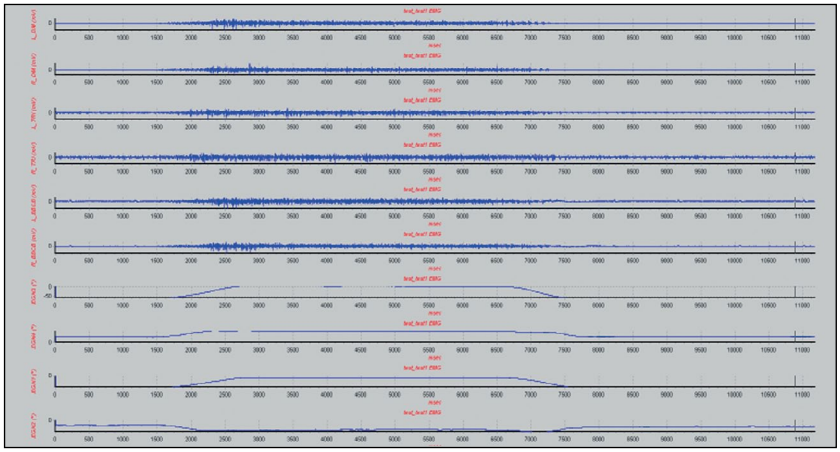

Fig. 6. Example of a protocol for processing received data.

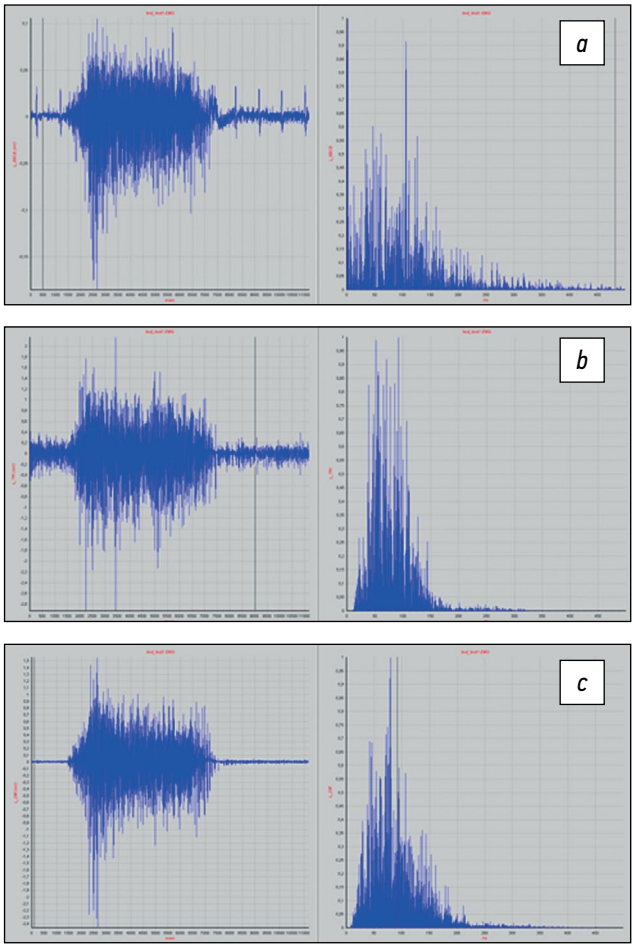

Fig. 7. Shoulder test, normal indicators: *a* — spectrogram of m. deltoideus, *b* — spectrogram of m. trapezius, *c* — spectrogram of m. biceps [11, 21, 22].

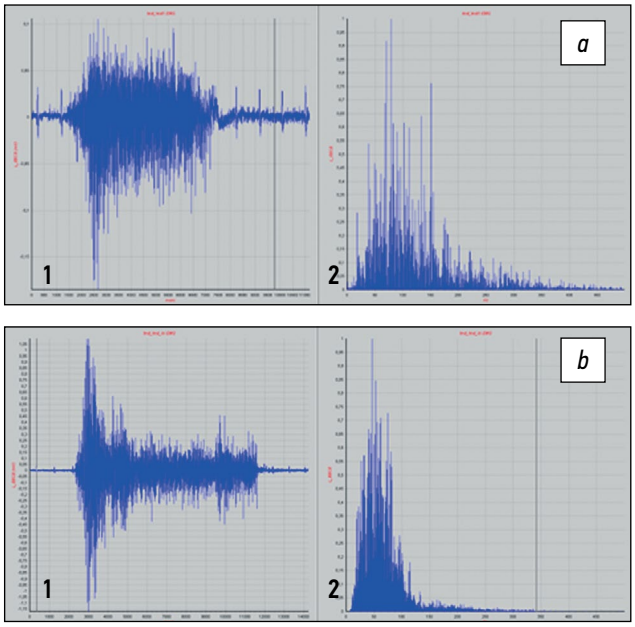

Fig. 8. Digital spectral analysis: *a* — shoulder abduction in the test: 1 — electromyography of m. biceps (average amplitude 42 μV), 2 — spectral density; *b* — forearm flexion: 1 — electromyography of m. biceps (average amplitude 237 μV), 2 — spectral density [8].

of the beak-like process of the scapula, which led to a decrease in athletic performance (weightlifters, athletes engaged in martial arts, boxing, etc.).

- The proprioceptive function of the shoulder joint decreased by 18.7%, which caused impairments in the fine coordination of movements, which is extremely important in sports such as rhythmic gymnastics, figure skating, and ballet.
- Arthroscopic stabilization using a free bone block did not affect shoulder proprioception; however, postoperatively, it preserves fine muscle coordination, which is very important in gymnastics, figure skating, ballet, etc.
- Free bone block surgery is more sparing than Latarjet surgery because the tendons of the short head of the m. biceps, m. subscapularis, and m. teres minor

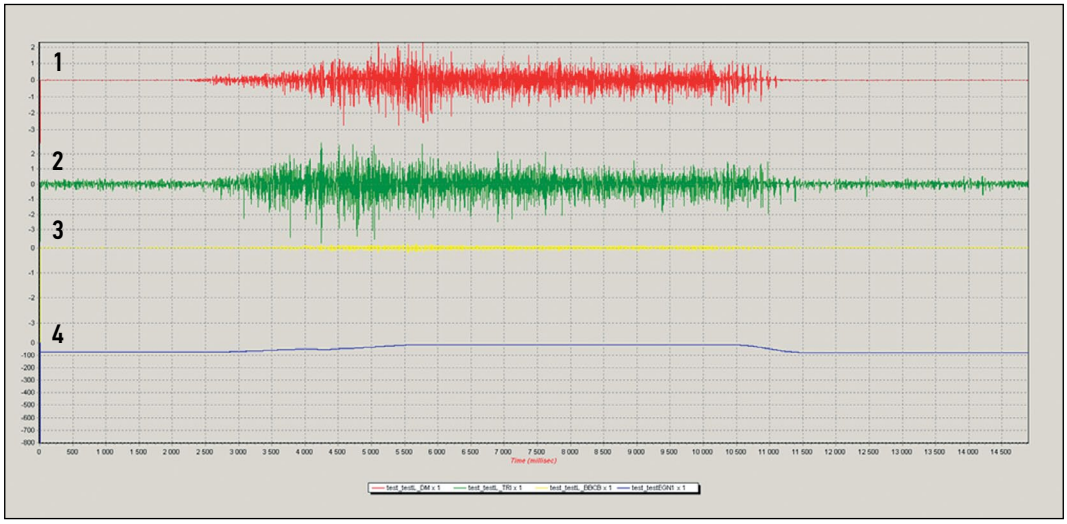

Fig. 9. 1 — electromyography of m. deltoideus (529 μV), 2 — electromyography of m. trapezius (481 μV), 3 — electromyography of m. biceps (42 μV), 4 — goniogram [9].

remain intact, which leads to a reduction in functional recovery by 3–4 weeks.

Clinical case study 1

Patient D (30 years old) was diagnosed with recurrent instability of the left shoulder joint (Master of Sports, International Sambo Class). In 2022, arthroscopic Latarjet surgery of the left shoulder joint was performed (Fig. 10).

Preoperative computed tomography and radiography were performed 6 months after the intervention. A study was also performed 7 months after the surgical treatment. The results of the clinical evaluation were good, no recurrences occurred, and the external shoulder rotation was slightly limited (Fig. 11).

In this patient, the spectral power of the left operated arm was reduced, which was most pronounced in the isometric phase (holding) (Fig. 12).

Maximum changes, such as spectrum narrowing, were also observed on the left side in the isometric phase. In the concentric and eccentric phases, slight differences from the right side were noted (Fig. 13).

Changes in the spectral power of the biceps on the affected side indicated its greater involvement in the motor pattern of shoulder extension and increased motor activity than on the opposite side (Fig. 14). The goniometric data indicated a failure of the isometric phase of the platysma by 10°. Interestingly, at the beginning of the eccentric phase, the angle of withdrawal increased by 5°. The aforementioned changes were attributed to the deficit of proprioceptive sensitivity and impairment of the biocontrol system of muscle activity.

Clinical case study 2

Patient N (27 years old) was diagnosed with recurrent instability of the left shoulder joint (honored master of sports in artistic gymnastics). In 2022, the patient underwent arthroscopic stabilization using a free bone autograft of the right humerus (Fig. 15).

The position of the bone autograft and results of the muscle functional status test performed 6 months after surgery to assess spectral power in the left arm are presented in Figs. 16–18.

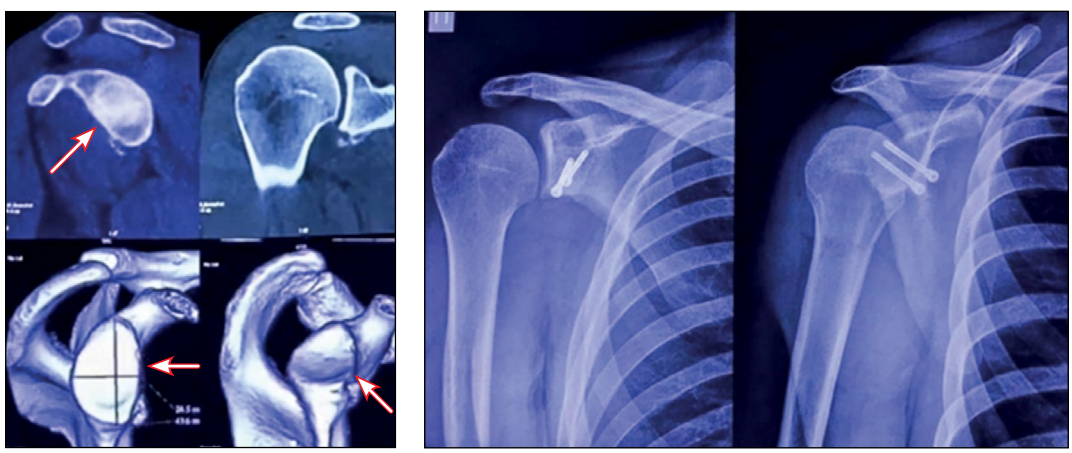

Fig. 10. Bone defect of the glenoid on preoperative computed tomography, control radiography 6 months after surgery.

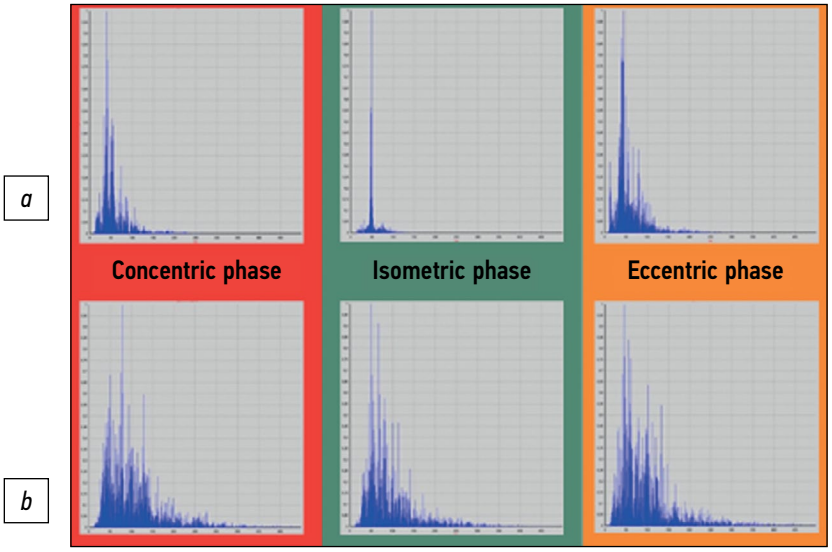

Fig. 11. Spectrograms of m. deltoideus: *a* — left hand, *b* — right hand.

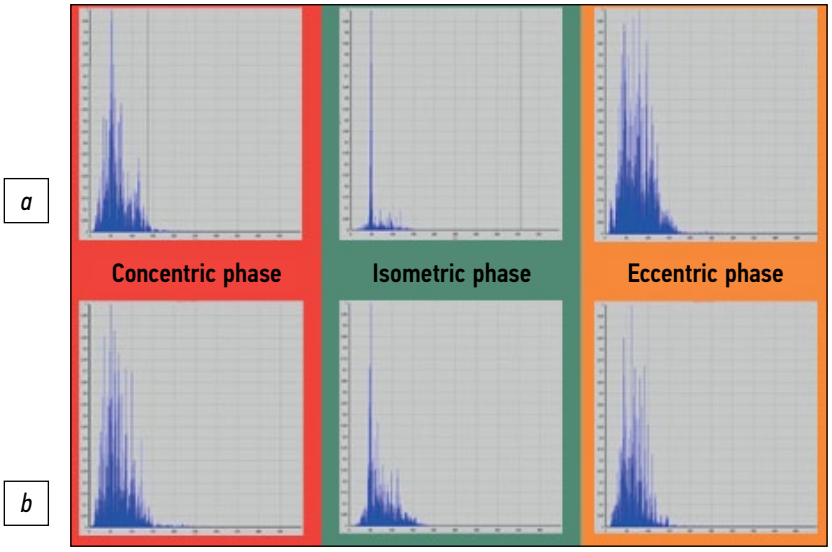

Fig. 12. Spectrograms of m. trapezius: *a* — left hand, *b* — right hand.

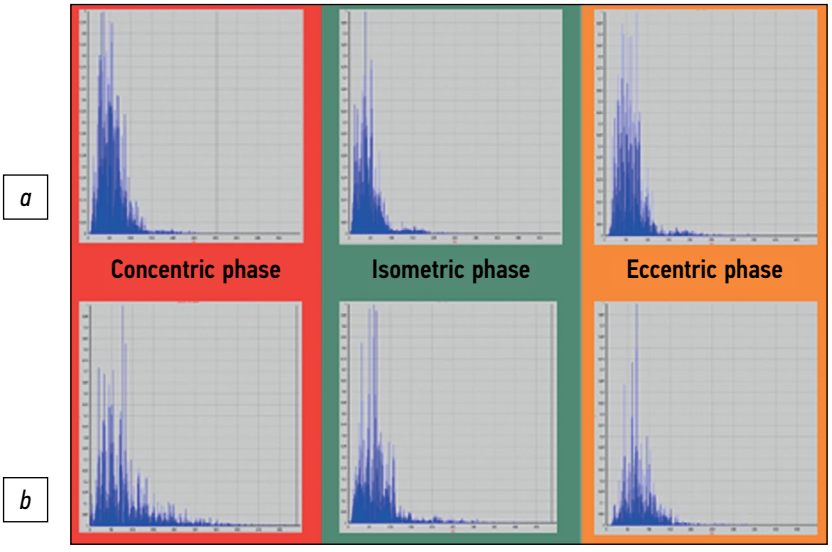

Fig. 13. Spectrograms of m. biceps: *a* — left hand, *b* — right hand.

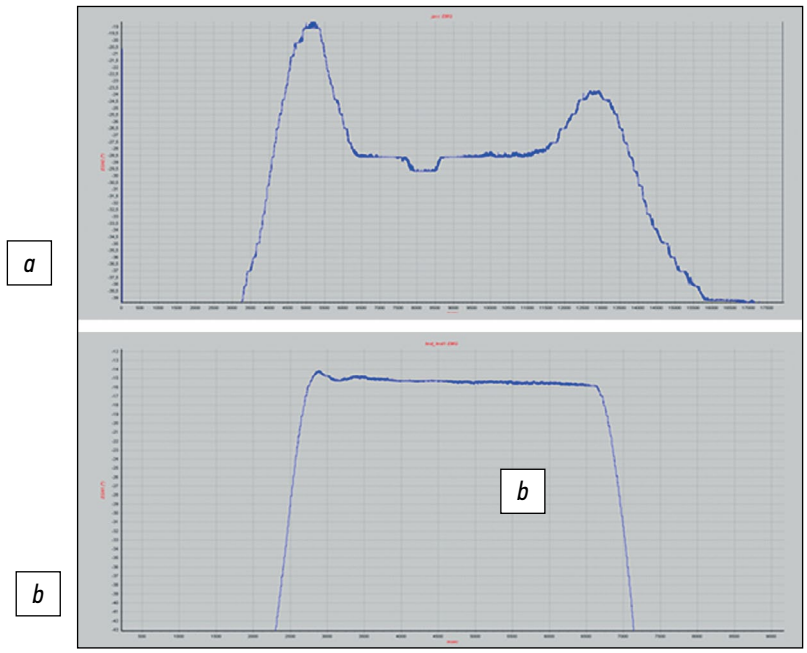

Fig. 14. Goniograms: *a* — left hand, *b* — right hand.

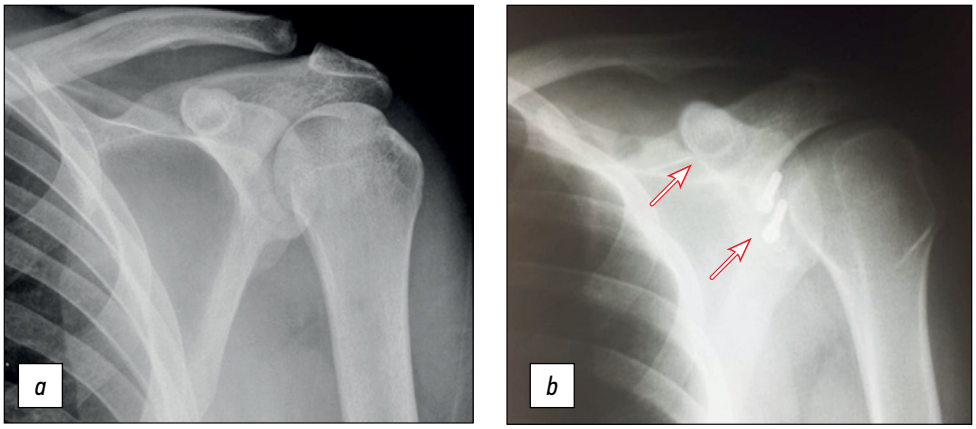

Fig. 15. X-ray of the right shoulder joint: *a* — before surgery, *b* — 6 months after it.

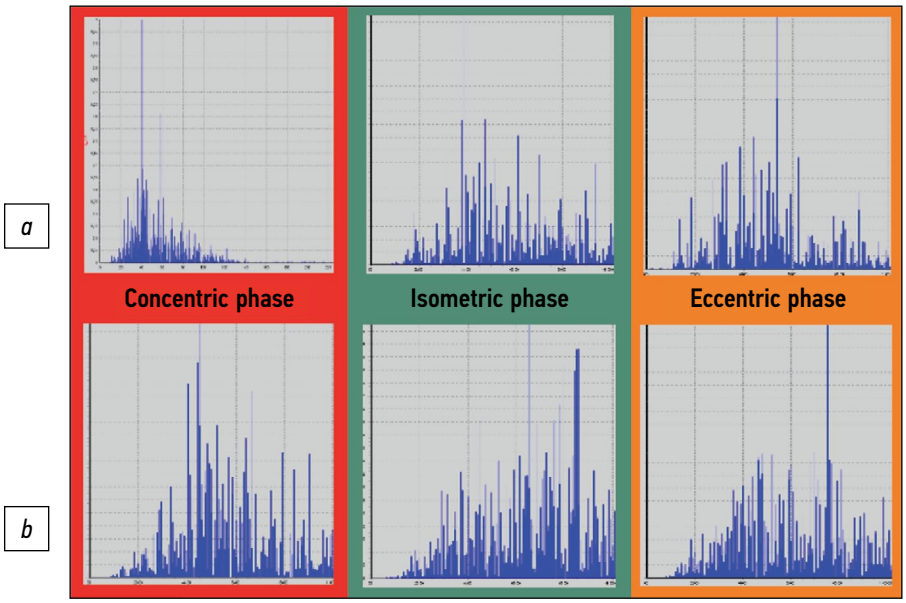

Fig. 16. Spectrograms of m. deltoideus: *a* — left hand, *b* — right hand.

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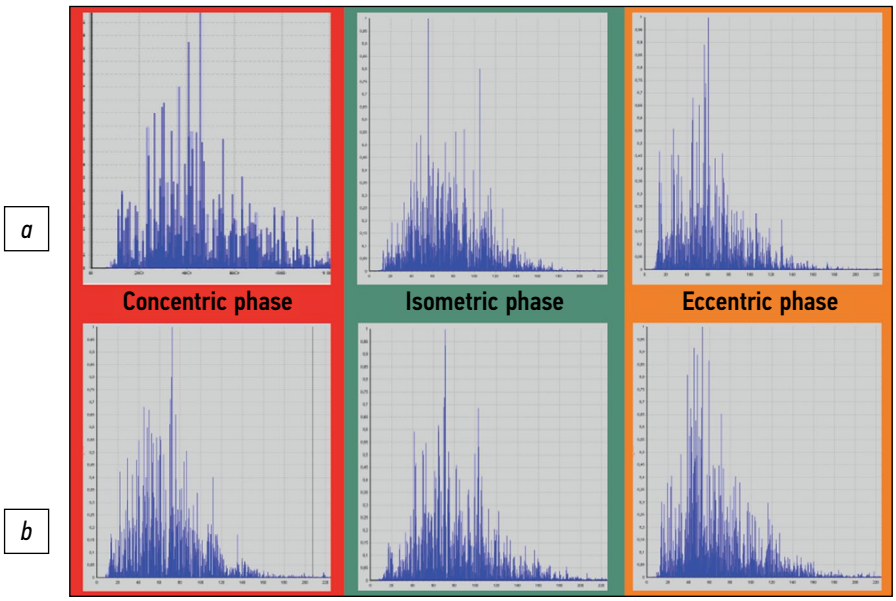

Fig. 17. Spectrograms of m. trapezius: *a* — left hand, *b* — right hand.

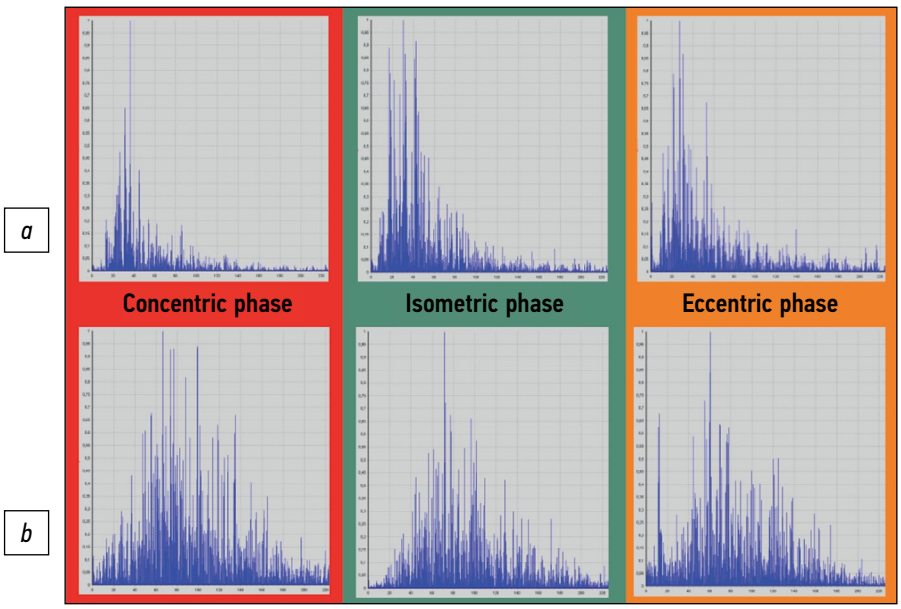

Fig. 18. Spectrograms of m. biceps: *a* — left hand, *b* — right hand.

Regarding the results of the examinations performed 6 months after surgery on the m. deltoideus, the goniometry data indicated adequate positional retention of the shoulder joint in the isometric phase and proprioceptive control (Fig. 19).

DISCUSSION

The results of the comparative analysis of the qualitative and quantitative kinesiological profiles of the shoulder joint in professionals and amateur athletes revealed that the specifics of sports should be considered when using different variants of arthroscopic stabilization. A free graft should be used in the stabilization of the shoulder joint of patients who need preservation of fine coordination of movements (gymnastics, ballet, figure skating, etc.) and those engaged in power sports (boxing, sambo, and wrestling), where a decrease in muscle strength indices will negatively affect the results during competitions. Team sports with the playing position of the upper limb above the head allow for Latarjet arthroscopic surgery without significant loss of athletic performance postoperatively.

CONCLUSION

Stabilization using a free bone block allows graft harvesting considering the bony defect of the articular surface of the scapula. A free bone block has fewer

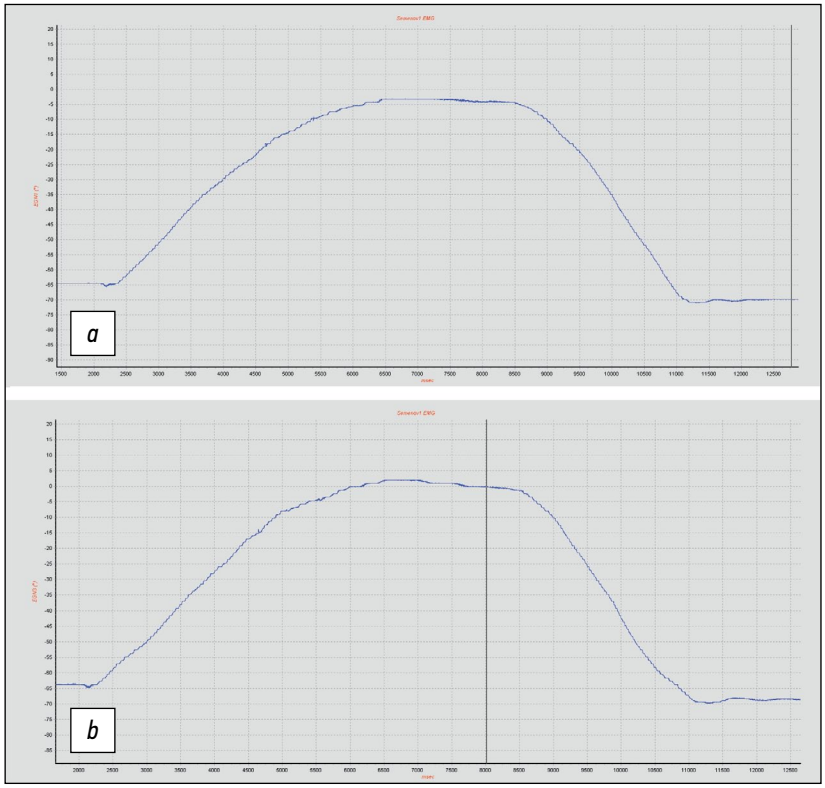

Fig. 19. Goniograms, plateau: *a* — left hand, *b* — right hand.

effects on the biokinematic aspects and proprioception of the shoulder joint, which does not affect the fine motor skills of the upper limb. In high-performance sports, a free graft is recommended for athletes of rhythmic and artistic gymnastics and synchronized swimming, which require finely coordinated movements of the upper limb for performing sports elements. Arthroscopic stabilization with a free bone block is also used in revision interventions following Latarjet surgery.

ДОПОЛНИТЕЛЬНО

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Consent for publication. Written consent was obtained from the patient for publication of relevant medical information and all of accompanying images within the manuscript.

СПИСОК ЛИТЕРАТУРЫ

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