

Diagnostic features in ruptures of the long head of the biceps

Irismetov Murod Ergashevich

Republican Specialized Scientific and Practical Medical Center for Traumatology and Orthopedics, Uzbekistan

Hamroyev Shaxzod Farhodovich

Republican Specialized Scientific and Practical Medical Center for Traumatology and Orthopedics, Uzbekistan

Shamshimetov Dilshod Fayzaxmatovich

Republican Specialized Scientific and Practical Medical Center for Traumatology and Orthopedics, Uzbekistan

Tadjinazarov Murod Bahodirovich

Republican Specialized Scientific and Practical Medical Center for Traumatology and Orthopedics, Uzbekistan

Rustamov Feruz Raupovich

Republican Specialized Scientific and Practical Medical Center for Traumatology and Orthopedics, Uzbekistan

Safarov Muhammad Maxmudovich

Republican Specialized Scientific and Practical Medical Center for Traumatology and Orthopedics, Uzbekistan

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Abstract: The article is devoted to the current issues of diagnosing ruptures of the tendon of the long head of the biceps brachii muscle (DGDMP), which are a common pathology in the practice of traumatologists-orthopedists and surgeons. The main clinical tests, such as the Yergason and Spid tests, which allow for the detection of characteristic injury symptoms (pain in supination and arm lifting), have been examined. However, their sensitivity and specificity are limited, necessitating the use of instrumental diagnostic methods. The article describes the advantages and disadvantages of ultrasound and magnetic resonance imaging. Ultrasound is an accessible and non-invasive method that allows visualization of tendon ruptures, especially during dynamic examination. MRI, in turn, provides high diagnostic accuracy (up to 98% specificity) and allows for the assessment of concomitant injuries such as rotating cuff tears or joint lip pathologies. Based on the analysis of clinical cases and research data, it has been shown that a combination of physical examination and MRI is the most effective strategy for diagnosis verification. Early and accurate diagnosis of BDMP ruptures plays a key role in choosing treatment tactics (conservative or surgical) and preventing complications such as chronic pain, decreased shoulder function, and development of arthrosis. The article is addressed to traumatologists-orthopedists, surgeons, and sports medicine specialists, and can also be useful for doctors engaged in the rehabilitation of patients with shoulder joint pathologies.

Keywords: Biceps rupture, diagnosis, ultrasound, MRI, clinical tests, differential diagnosis.

Introduction: Clinical features

Injuries to the tendon of the long head of the biceps brachii muscle each have their own distinct

characteristics during anamnesis and physical examination, which help the doctor make an accurate diagnosis during conversation with the patient.

Taking a medical history begins with determining which arm is dominant and the patient's occupation, as this allows the physician to understand injuries caused by overexertion and the functional demands on the long head tendon of the patient's biceps brachii muscle.

Constant physical exertion, especially activities or occupations that require arm abduction and flexion movements, can lead to chronic damage of the long head tendon of the biceps brachii muscle and rotator cuff with a 94% probability.

The patient's complaints are the most crucial part of collecting the anamnesis and help to correctly diagnose a tendon problem. Patients often seek medical attention with clear knowledge of a "rupture" or with a diagnosis from another doctor.

It is important to determine the exact location of pain in the patient, who usually indicates pain on the anterior and medial side of the shoulder, along the tendon of the long head of the biceps brachii muscle. Pathology of the long head tendon of the biceps brachii muscle is more common among tall athletes and shorter, but older patients. Patients may also complain of pain radiating to the forearm or biceps muscle.

Based on the patient's indication of pain localization, it is possible to infer the affected structure in the patient's shoulder area (Fig. 1).

Pain at point P is characteristic of rotator cuff injuries, subacromial bursitis, and impingement syndrome. Pain at point C indicates rotator cuff tear, SLAP-type injury, and adhesive capsulitis. Pain in the D region is characteristic of tendinitis. Pain at point S is characteristic of acromioclavicular arthritis.

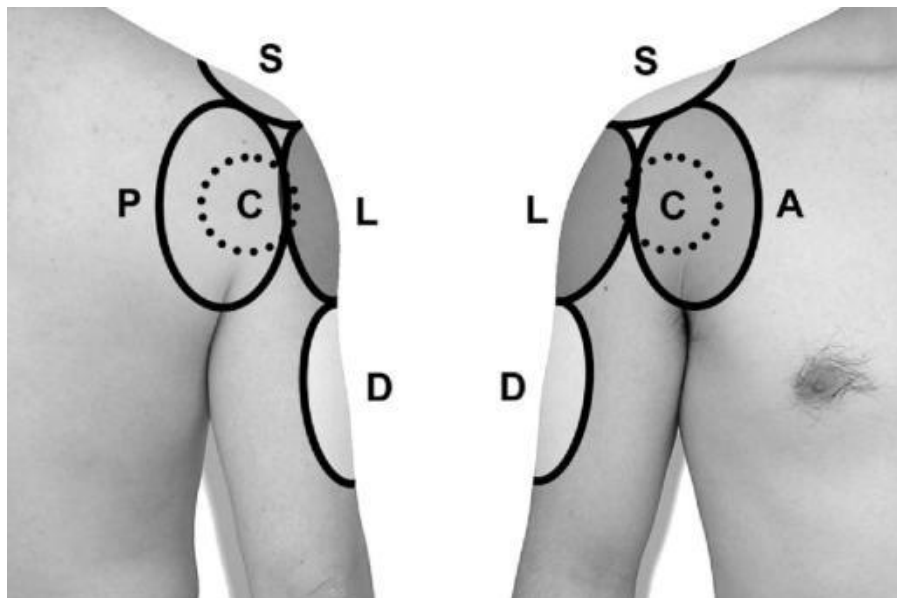


Figure 1. Localization of pain in the shoulder joint and shoulder area.

The timing of the injury, whether it occurred a few days or months ago, is important as it helps the surgeon prepare for the procedure accordingly.

Patients should also be asked about any neurological symptoms (numbness, tingling, etc.), as there may be similarities between tendon injuries and cervical osteochondrosis or compression neuropathies.

Physical examination of injuries to the long head tendon of the biceps brachii muscle begins with an inspection, during which the patient's shoulders should be exposed. During the examination of the shoulder joint, anterior, posterior, and lateral views are assessed. An important aspect of the examination

consists of checking the symmetry of the shoulder and shoulder joints, muscle characteristics, and the contours of bone structures. The examination begins with inspection for any bruising, swelling, or deformity of the shoulder, paying particular attention to the structure of the scapula and the muscle belly of the shoulder. A difference in appearance of the biceps brachii muscle belly compared to the other arm indicates a rupture of the long head tendon. This condition, called "Popeye deformity," is characterized by drooping and laxity of the long head tendon of the biceps brachii muscle (Fig. 2).



Figure 2. Patient Y.A. shows "Popeye" deformity during examination.

In patients with chronic degenerative pathology of the shoulder joint, secondary changes in the form of atrophy or hypotrophy of the shoulder muscles were observed. Additionally, to rule out neurotropic

pathologies in such patients, neuromyography was performed, and a neurologist was consulted. These patients were recommended strict treatment under the supervision of a neurologist (Fig. 3).



Figure 3. Patient I.D. The examination revealed an injury to the rotator cuff of the shoulder. The examination shows hypotrophy of the shoulder muscles and "Popeye" deformity.

During palpation, general principles such as examining bone structures and soft tissues were followed. Special attention was paid to edema and its spread, crepitus, location of pain, muscle mobility and strength, as well as local temperature increase.

To measure the functional limitation of the range of

motion in the shoulder joint, the volume of upper arm movements was measured according to the following norms:

- adduction 180 degrees,
- Combination of adduction with extension or flexion in the range of 45-60°, complete flexion up to

180°

- extension 50-60°,
- internal rotation 110°,
- external rotation 70-80°.

Flexion range is measured as follows: the patient raises their arm as far forward and upward as possible without the doctor's assistance. In this position, the center of the goniometer is placed at the level of the joint cavity, with one end directed along the shoulder axis and the other vertically downward.

To measure shoulder abduction, the doctor stands behind the patient and stabilizes their shoulder blade. The patient raises their arm to the side. The center of the goniometer is placed in the middle of the shoulder, with one end along the shoulder axis and the other vertically downward.

There are two methods to measure the range of rotation in the shoulder joint.

In the first method, only external rotation is evaluated. The patient's arms are positioned along the body with elbows bent. The patient should rotate their arm outward without moving their elbow away from their body.

The second method is performed as follows. The patient extends their arm to the side, bent at a right angle at the elbow. Then the subject alternately turns their palm upward (external rotation) and downward (internal rotation).

Special tests are not used when assessing passive movements. For a comparative evaluation of treatment results, it is necessary to record passive movements. The assessment of passive movements was carried out with the shoulder girdle stabilized. Movements in different planes were evaluated.

The long head tendon of the biceps brachii muscle may present with painful crackling or pain on palpation during full lateral elevation and external rotation when unstable. If there is a difference in the range of active motion (ROM) between the two arms, it is necessary to determine the difference between active and passive ROM by passively moving the patient's shoulder. This is often observed in rotator cuff injuries (when passive ROM is greater than active ROM) or in adhesive capsulitis (when passive ROM is equal to active ROM).

Then specific diagnostic tests were performed on the patient.

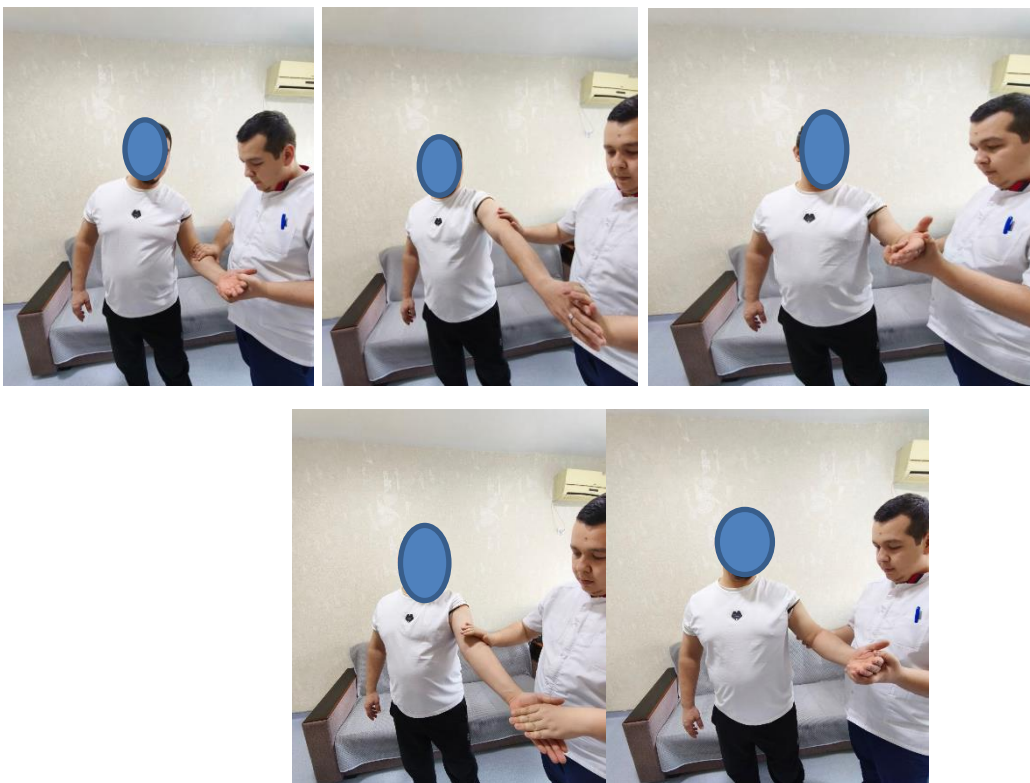


Figure 4. Patient during specific diagnostic tests

Active compression test: The doctor stands behind the patient, bending the shoulder forward by 90°, bringing it to an adduction position of 10-15°. In this position,

the elbow is fully extended, the shoulder is maximally internally rotated, and the forearm is in pronation (thumb pointing downwards). While the patient resists,

the doctor applies downward pressure on the shoulder. Then this movement is repeated with the forearm in supination (thumb facing upward). Pain that occurs during forearm pronation and disappears during supination is considered a positive test and indicates biceps/labrum pathology. Studies have reported 100% sensitivity and 99% specificity. It is important to precisely locate the pain, as pain in the acromioclavicular joint or upper shoulder indicates acromioclavicular joint pathology, but this does not always mean that the biceps brachii tendon is ruptured.

Speed's test. The patient's shoulder is positioned in forward flexion, external rotation, with the elbow extended and forearm supinated. The examiner applies downward force, which the patient resists. Pain along the biceps brachii muscle is considered a positive result. According to studies, specificity is 13.8%, and sensitivity is 90%.

Yergason test. With the elbow flexed at 90°, the patient is asked to actively supinate the forearm against resistance. If the patient feels pain in the biceps brachii region, the test is considered positive. Studies have shown a specificity of 79% and sensitivity of 41%.

Uppercut test. The patient makes a fist with the forearm in supination and the elbow flexed at 90°. The examiner applies a downward force to the patient's fist, while the patient tries to raise their hand to their chin

(similar to an uppercut punch in boxing). Studies have reported a prognostic value of 78% specificity and 73% sensitivity.

Throwing test. The examiner stands behind the patient. The shoulder is elevated to 90°, the elbow is flexed to 90°, and the arm is maximally externally rotated, resembling a throwing position. The patient steps forward with the opposite leg and imitates a throwing motion, while the examiner provides isometric resistance. Assessments have noted 72-75% sensitivity and 64-78% specificity.

It is advisable to perform the above tests in combination for a more accurate diagnosis of injuries to the long head of the biceps brachii tendon. A positive result in at least three tests during examination indicates tendon injury.

Radiological examination

Patients underwent radiological examination of the shoulder joint in the anterior-posterior projection according to the standard method.

Performing radiography in the anterior projection included simple anterior-posterior radiographs with the arm in a neutral position. The X-ray beam was directed at a 20° angle in the cranio-caudal direction. All radiographs were taken with the patient in a standing position.

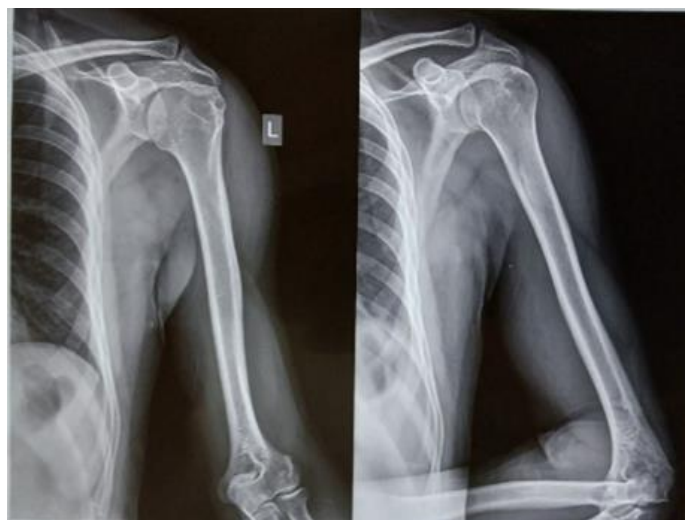


Figure 5. Patient I.D. 53 years old. Result of a standard anterior radiological examination of the left shoulder region.

Ultrasound examination.

Ultrasound examination was performed using a Siemens Sonoline Elagra (Siemens Medical Systems, Mountain View, California, USA) device equipped with a high-quality (13 MHz) linear transducer. This ensured high spatial resolution (up to 0.1 mm). To reduce

anisotropy artifacts, the angle of the transducer relative to the tendon axis was adjusted. The examination was conducted in real-time (B-mode) and color Doppler mapping (CDM) was additionally used to assess tissue blood supply.

The ultrasound examination of the patient was carried out as follows:

The patient was seated with arms relaxed on the knees, in a neutral position (elbow joint bent at a 90° angle, forearm pronated). For dynamic assessment of the tendon, passive movements were performed: flexion/extension of the elbow, supination/pronation of the forearm.

Areas examined:

- Bicipital groove - the main area of focus.
- Proximal part of the tendon (muscle-tendon junction).
- Distal part (when associated injuries are suspected).

Comparative analysis: To determine asymmetry in tendon thickness and echogenicity, the contralateral (healthy) side was used for comparison.



Figure 5. S.A. 50 years old. During ultrasound examination

Evaluated parameters:

- Tendon morphology: fiber continuity, thickness, presence of deformations.
- Echogenicity: structural homogeneity, hypo-/hyperechoic inclusions.
- Dynamic changes: tendon displacement during movement, signs of impingement.
- Associated pathologies: bursitis, synovitis, calcifications

In addition, the examination revealed the following accompanying changes:

- Uneven echogenicity - alternation of hypo- and hyperechogenic areas, observed in cases of tendinopathy.
- Calcifications - hyperechoic inclusions (1-3 mm in diameter) producing acoustic shadows.
- Synovitis - thickening of the synovial membrane (>2 mm) and increased vascularization (blood flow index >0.7 on Doppler examination).

MRI examination.

MRI examination with a magnetic field strength of 1.5 Tesla to determine the form and degree of damage to the elements of the shoulder joint.

Magnetic resonance imaging was performed on a "Philips" tomograph with a 1.5 Tesla magnetic field. The study was conducted in standard, transverse (T2) mode. Additionally, high-density proton (PD) images were obtained in axial, sagittal, and coronal projections.

Protocol for conducting an MRI of the shoulder joint. The following sequences were obtained on a 1.5 T MRI device: T1-weighted spin-echo images in the coronal oblique, transverse, and sagittal oblique planes. T2-weighted fast spin-echo images and proton density fast spin-echo images were obtained in the coronal oblique plane. T2 fat-suppressed fast spin-echo and proton density fat-suppressed fast spin-echo images were obtained in the coronal plane.

MRI examinations of patients were conducted using 2 different methods.

1. In the first group of patients, MRI was performed in a standard manner, and the examination was carried out as follows (n=36; 69.2%): The patient lies on their back on the MRI table; the arm to be examined should be extended along the body or slightly pulled away for better access to the shoulder area; the patient's comfort is ensured using pillows or rollers to support the elbow and shoulder area and reduce muscle tension; the patient is instructed to remain in a stable

and relaxed position to prevent artifacts in the images due to movement.

- A special coil (usually a surface coil) designed for examining the shoulder joint is used, which has a shape that allows optimal positioning around the area being studied.
- The coil is positioned so that it covers both the shoulder joint and the biceps muscle, and the area of study includes the shoulder and clavicle, as well as the

surrounding soft tissues.

- The coil is placed on the upper part of the shoulder and partially covers the upper arm, which ensures optimal quality of signals from the biceps soft tissues and joint structures.
- It must be securely fastened to prevent slipping during scanning, while the elbow joint area must remain free from the coil.



Figure 6. Standard shoulder region MRI examination procedure

2. In the second group of patients, MRI examination was conducted using a special method developed by us (n=16; 30.8%). The main stages of MRI diagnostics for the rupture of the long head tendon of the biceps brachii muscle using our developed method were as follows:

Patient preparation:

- The patient is positioned supine on the MRI machine.
- Arm positioning: The elbow joint is bent to the maximum possible angle (160-180°), with the palm facing the shoulder.
- The forearm is fixed in a supination position to stretch the tendon of the long head of the biceps brachii muscle.

- The scanning area (shoulder) is placed on a special coil designed for this purpose.

Device setup:

- A high-field MRI scanner (1.5 T) was used.
- T2-weighted with fat suppression (STIR) - for detecting edema and inflammation.
- T1-weighted - for assessing the anatomy of tendons and ligaments.
- Thin-slice (0.3-0.5 mm) proton density (PD) - for detailed visualization of micro-ruptures.

Scanning planes:

- Axial - for analyzing the cross-section of structures.
- Sagittal - for assessing tendon length.

- Coronal - for imaging medial and lateral structures.



Figure 7. Patient during MRI examination using our proposed method

The following pathological conditions were identified using MRI:

- Disruption of tendon continuity.
- Muscle retraction ("Popeye sign").
- High-intensity signal in T2-weighted images (edema, hematoma).

MRI was used to achieve the following:

- Clear visualization of soft tissues: MRI allows for a detailed assessment of the integrity of the long head tendon of the biceps brachii muscle, detection of complete and partial ruptures, as well as their location (for example, in the bicipital groove or at the scapular attachment site).
- Assessment of concomitant injuries: Rotator cuff tear of the shoulder. Labral injury (SLAP lesion). Bursitis, synovitis, impingement syndrome.
- Differential diagnosis: Exclusion of other causes of shoulder pain (arthritis, tumors, nervous system disorders).

Comparative analysis of clinical and instrumental examinations.

When a rupture of the long head tendon of the biceps brachii muscle is suspected, clinical examinations are crucial for preliminary diagnosis and determining the method of further treatment. The main purpose of these examinations is to quickly identify signs of injury without additional expenses, differentiate it from other diseases, and determine the need for instrumental confirmation.

Clinical examinations are convenient because they don't require special equipment and can be performed on an outpatient basis, the costs are minimal, and they allow for checking tendon function during movement. However, the results depend on the doctor's

experience and the accuracy of the tests. Additionally, tendinitis and bursitis can present symptoms similar to tendon rupture and may give false positive results.

Clinical examinations are the foundation for diagnosing rupture of the long head tendon of the biceps brachii muscle. This allows the patient to quickly narrow down the range of possible diseases and determine the need for in-depth diagnosis.

However, for the final diagnosis and planning of surgical intervention, clinical data must be used in combination with instrumental research methods (ultrasound, magnetic resonance imaging). The combination of approaches ensures the highest accuracy and reduces the risk of error.

Because the long head of the biceps brachii muscle is a structural connective tissue, radiological examination does not directly contribute to diagnosing tendon rupture and is carried out with the following goals:

- Ruling out concomitant bone injuries: X-rays allow for the detection of fractures (e.g., a large tubercle of the humerus), dislocations, or cracks that may accompany the injury. This is especially important in combined injuries (falls, impacts).
- Diagnosing chronic pathologies: Signs of calcifications, osteophytes (bone growths), or arthrosis in the tendon area.
- Assessing anatomical features: The presence of bone structure anomalies (for example, deformation of the groove between the tubercles) increases the risk of injury to the long head tendon of the biceps brachii muscle.
- Differential diagnosis: Excluding other causes of pain in the shoulder or arm, such as arthritis, osteomyelitis, or tumors.

Despite its advantages, this diagnostic method cannot

provide a 100% diagnosis in our case due to two undeniable factors:

1. It does not show soft tissues: X-ray cannot detect ruptures of tendons, muscles, or ligaments.
2. False-negative results: Even if the long head tendon of the biceps brachii is completely severed, it is impossible to diagnose tendon rupture based on indirect radiological signs. Even if the tendon is ruptured, the test result can appear "clear."

Therefore, in cases with a risk of fracture (falls, road traffic accidents), deformation, crepitus, or limited movement in the shoulder area, it is advisable to conduct an X-ray examination to plan surgical intervention (for example, when impingement syndrome is suspected).

Thus, in cases of rupture of the long head tendon of the biceps brachii muscle, X-ray examination is not used for direct diagnosis but is important for ruling out bone diseases and comprehensively assessing the injury. Ultrasound and MRI scans are always necessary to confirm tendon rupture.

Ultrasound enabled a detailed assessment of the integrity of the biceps tendon and shoulder muscles, identifying complete or partial ruptures, as well as associated injuries (hematomas, hemorrhages).

Dynamic assessment of the pathology, i.e., observing the tendon position during movement (flexion/extension, internal/external rotation), allows for the detection of instability or rupture.

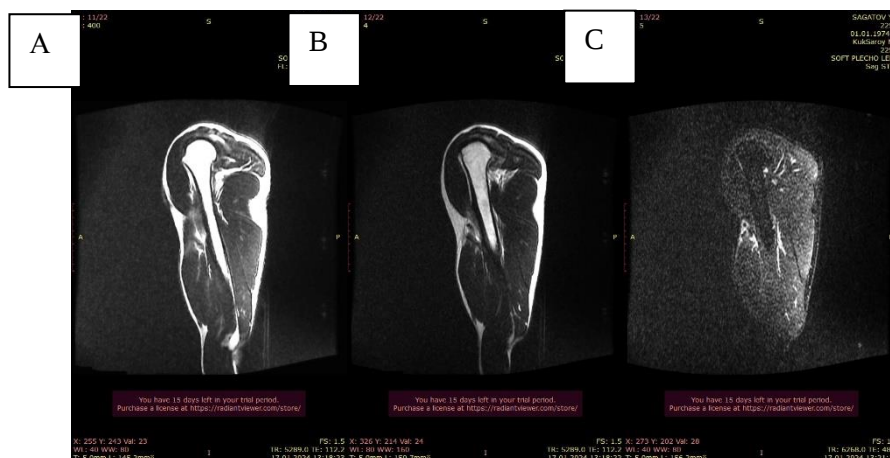
The following advantages of ultrasound examination were observed:

- High accuracy: sensitivity for complete ruptures - 95-98%, for partial ruptures - 80-85%.
- Ability to determine the location of the rupture (for example, the groove between the tubercles, the muscle-tendon junction).
- Safety and comfort: Absence of ionizing radiation (can be used in children, pregnant women). Lower cost compared to MRI.
- Speed: The test lasts 10-15 minutes, with results obtained immediately.

The following limitations of ultrasound were identified:

- Subjective dependence: Accuracy depends on the doctor's experience and the quality of the equipment.
- Limitations in obesity: Decreased image quality due to the deep location of structures.
- Difficulties in chronic processes: Scarring or calcifications can make interpretation of results difficult.

MRI analysis is the most significant examination method for soft tissue structure injuries, as it is considered the "gold standard" for long head tendon ruptures of the biceps brachii muscle due to its high accuracy (sensitivity and specificity reaching 95-98% even for partial ruptures), ability to assess the degree of tendon retraction (displacement), visualization of all soft tissue layers (muscles, tendons, ligaments, nerves), detection of microtraumas and degenerative changes (tendinosis), absence of ionizing radiation, and minimal contraindications (except for the presence of metal implants and pacemakers).



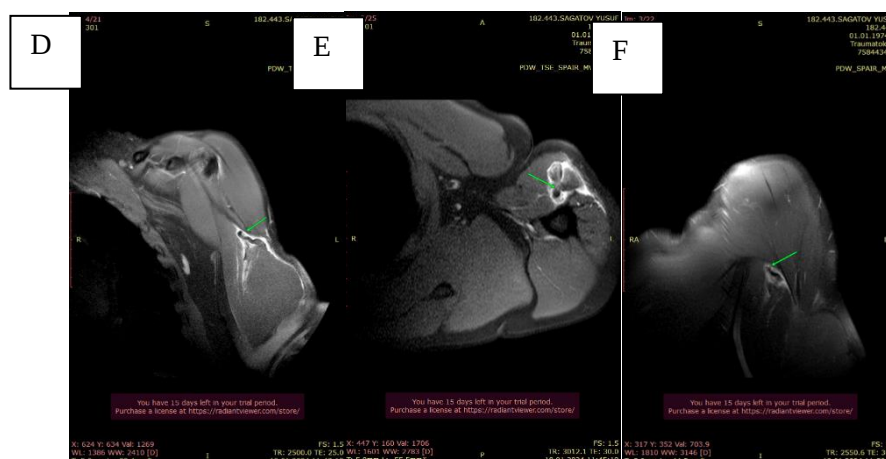


Figure 8.A, B, C - MRI diagnosis of patient S.Yu. in standard position

D, E, F - MRI diagnosis of patient S.Yu. in the position we developed

The MRI examination of the long head tendon of the biceps brachii muscle that we have developed has the following advantages:

Improved visualization of tense structures:

a. In a fully flexed position, the biceps and triceps tendons are maximally tense, which allows for the detection of:

- Partial ruptures that are imperceptible in the neutral position.
- Layering of tendon fibers.

b. Ligaments (e.g., the lateral ulnar collateral ligament) are better differentiated from surrounding tissues.

Reduction of artifacts:

a. The tight contact of soft tissues with the coil reduces motion artifacts.

b. The effect of "overlapping" adjacent structures (e.g., the heads of the radius and ulna) is minimized.

Diagnosis of hidden pathologies:

a. Compression of nerves (e.g., the ulnar nerve) is more clearly visible when flexed.

Optimization of the surgical plan: Accurate localization of the tendon rupture allows for the selection of the optimal surgical approach (e.g., arthroscopic or open).

- Anisotropy artifacts: False low echogenicity is observed when the probe is held at an incorrect angle.

Ultrasound is the first-choice method for detecting biceps ruptures due to its safety, convenience, and the possibility of dynamic assessment. However, in complex cases or when planning surgical intervention, it is recommended to supplement ultrasound with MRI.

The correct positioning of the patient and proper placement of coils are crucial factors in obtaining high-

quality shoulder MRI images, especially when diagnosing ruptures of the long head tendon of the biceps brachii muscle. This enables better visualization of soft tissues, ensuring the accuracy and reliability of the examination results.

MRI is particularly important in cases of long head biceps tendon ruptures, especially in complex situations where ultrasound or clinical examination fails to provide accurate results. Despite its high cost and limitations, MRI remains the "gold standard" for diagnosing soft tissue injuries of the shoulder joint.

CONCLUSION

By analyzing the clinical and instrumental data of patients with ruptures of the long head tendon of the biceps brachii muscle, it was possible to identify the key principles that are crucial for diagnosing this pathology and selecting the appropriate treatment approach. In most patients, the clinical picture was characterized by acute or chronic pain syndrome in the anterior-superior region of the shoulder joint, which intensified with exertion, as well as a decrease in flexion and supination strength in the elbow joint. Patients showed positive results in more than 70% of cases with the "Popeye deformity" symptom, Speed's test, and Yergason test, which confirms the high informativeness of clinical examinations.

Analysis of the data showed that in patients over 50 years of age, degenerative tears associated with tendinopathy predominated, while in younger patients, traumatic injuries were often accompanied by rotator cuff pathology. The diversity of clinical outcomes (from asymptomatic to pronounced dysfunction) emphasizes the need for individualized treatment, taking into account age, level of physical activity, and the nature of the injury.

Considering the patient's complaints, conducting clinical and instrumental examinations, and selecting a treatment plan based on these findings became the foundation of the algorithm we developed.

Thus, a comprehensive analysis of clinical and instrumental data not only improves the accuracy of diagnosis but also reduces the risk of incorrect decisions and forms an evidence-based foundation for an individualized approach to treatment.

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