Clinical case
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Effective combination of arthroscopic and minimally invasive surgery for chronic posterolateral elbow instability

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Abstract

Introduction Trauma and extreme physical activity may result in common patterns of forearm dislocation, which account for 10 to 25 % of all elbow injuries in the adult population. Good long-term results of eliminating joint dislocation with the use of conservative treatment have been much described, but 8 % of patients experience symptoms of chronic instability. We present a case of successful arthroscopic treatment of ligamentous stabilizers of the elbow joint using an effective combination of implants for its posterolateral instability. We found no publications on such an experience in the Russian literature.

The **purpose** of the work is to present a clinical case of an effective combination of arthroscopic and minimally invasive surgery methods for reconstruction of the ligamentous apparatus in chronic posterolateral instability of the elbow joint.

Material and methods Patient N., 31 years old, suffered chronic posterolateral rotational instability of the left elbow joint after dislocation of the forearm bones for more than 10 years. The operative technique was based on the principles of minimally invasive reconstructive plastic surgery and meets the objectives of gentle treatment of soft tissues, allowing visualization of the lesion and avoiding the contact with neuro-vascular structures. Baseline clinical tests (O'Driscoll, Regan/Lapner, Pollock), questionnaires (VAS, DASH, MEPS, SF-36), and MRI, 1.5 Tesla MRI scans of dynamic stabilizer disruption are reflected. Evaluation was performed at two control points (45 and 180 days).

Results The assessment was carried out at two control points. First follow-up (45 days): flexion/extension 50/175º, pronation/supination 90/90º, VAS 2, DASH 24.2, MEPS 80 points, respectively. Second follow-up (180 days): VAS 1, DASH 9.2, MEPS 95 points, comparative ranges of motion corresponded to a healthy joint. An MRI study confirmed the progress of the autotenograft and tendon ligamentization in the area of reinsertion, the absence of inflammatory changes and no heterotopic ossification.

Discussion Improvements in elbow surgery and technical progress are focused on minimally invasive interventions, while arthroscopy of the elbow joint is still technically difficult due to a limited space. And yet, this is an effective treatment method, as a result of which specialists can avoid a wide range of complications (14.7 %), and patients start rehabilitation faster and, as a result, recover faster than with open surgical approaches with a higher percentage of risks (52 %).

Conclusion The combination of the above techniques avoids conflict with neurovascular structures, provides visual control of the implantation of anchors and, as a result, reduces the overall risk of complications in the treatment of a rare group of patients with instability of the elbow joint.

Keywords: elbow joint, arthroscopic treatment, dislocation of the forearm bones, sports medicine, posterolateral elbow instability, collateral ligaments

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INTRODUCTION

The elbow joint consists of a complex of bone and ligament stabilizers that provide both mechanical and dynamic limitation of dislocation of the forearm bones. Due to injuries and extreme physical exertion, classical patterns of dislocation may occur that account for 10–25 % of all elbow joint injuries in the adult population, while the incidence rate is 7 cases per 100,000 people a year. A quarter of the conditions are accompanied by a fracture of the bone structures that make up the elbow joint, in 60 % of cases the non-dominant extremity is involved [1–4].

Falls on an extended elbow joint resulting from low-energy injuries are the most common mechanism of forearm bone dislocation (56.5 %) in everyday life activities and extremely rare in sport activities (4 %) [1, 4]. Such dislocations at the age of 10–19 years are more common in men (53 % to 47 % in women) and are frequently combined with shoulder or wrist injuries (10–15 %) [5]. It is reported that 6 out of 58 (10 %) forearm bone dislocations in children require open surgery. Interposition of the medial epicondyle of the humerus by intra-articular fragments is the most common cause of reduction difficulties [5, 6]. The effectiveness of therapeutic measures is determined by knowledge of the anatomy and biomechanics of the joint, as well as by the vectors of force that preceded the primary dislocation.

There are three primary static stabilizers of the elbow joint: the humeroulnar joint, the anterior portion of the medial ulnar collateral ligament (MUCL), and the lateral collateral ligament complex (LCLC). Secondary stabilizers include the humeroradial joint, the tendons of the flexor and extensor muscle groups of the wrist (m. flexor carpi radialis et ulnaris, m. extensor capri radialis longus et brevis, etc.), and the capsule. The muscles that cross the elbow joint (m. pronator teres, m. brachialis, m. anconeus, etc.) are dynamic stabilizers. The LCLC provides varus stability of the elbow joint and includes the annular ligament, fibers of the accessory lateral collateral ligament, the lateral ulnar collateral ligament (LUCL) and the radial collateral ligament (RCL). The antagonist of the lateral collateral ligament complex is the MUCL that consists of the anterior oblique, posterior and transverse portions (Cooper's ligament) [7].

Currently, three types of post-traumatic instability of the elbow joint have been identified, associated with the mechanism of injury and disruption of the anatomical structures [8]:

— posterolateral rotational instability (PLRI) develops after damage to the LCLC due to a fall on an outstretched arm and is the most common (80%);

— valgus instability (VI) is caused by injury to the MUCL due to a cyclic traction mechanism, often found in athletes who regularly throw a ball;

— posteromedial varus instability (PMVI) is typical for elbow injuries accompanied by damage to the ligament associated with a fracture in the ulna.

In diagnostic terms, post-traumatic instability of the elbow joint can be determined by instrumental methods of visual diagnostics and with the help of provocative tests. The O'Driscoll dynamic valgus stress test is 100 % sensitive and 75 % specific for injuries of the medial stabilizing complex in VI, as well as the lateral pivot-shift test, suitable for PLRI. Regan et Lapner presented a push-up and chair-stand load test with a sensitivity of 87.5 % (100 % with sequential use of both tests) for identifying PLRI [9]. The Pollock gravity stress test is the most sensitive and specific for PMVI [1, 3]. It is important to know that some tests can be performed only after the implementation of conduction or general anesthesia in patients, otherwise the sensitivity will not exceed 38% and will be hampered by pain syndrome.

CT has a sensitivity of 71–86% and a specificity of 91% and is routinely used to evaluate the disruption of the architec-ture of the bone stabilizers in the forearm fracture-dislocation model. In the context of chronic post-traumatic elbow instability, provocation of the coronoid process is best seen in VI [1, 3]. MRI allows evaluation of the structures of soft tissue stabilizers, including the LCLC/LUCL/MUCL, and visualization of the osteochondral fragments of the trochlea humeri or fossa olecrani [3, 6, 10]. Magnetic resonance imaging has a sensitivity of 57–79% in detecting VI and is 100% specific for damage to the ligamentous apparatus structures [1]. Radiography of the elbow joint in standard views does not have a high degree of specificity for this nosology, which can be increased by using an image intersifier for dynamic radiography [1]. The method allows vizualizing avulsion fractures, intra-articular chondral bodies or heterotopic osteophytes of the ulnar processes, which are indirect signs of post-traumatic instability of the elbow joint.

In academic terms, the classifications of Albert (1881), Gui (1957) and Morrey (1996) are of interest; however, according to some authors, the most relevant in practical terms are the classifications of O'Driscoll (2000) and SICSeG (Italian Society of Shoulder and Elbow Surgery, 2015) [11]. The O'Driscoll classification defines the complexity of the dislocation of the forearm bones and post-traumatic instability of the elbow joint according to the criteria: time, involved joints, direction, severity, concomitant fractures. The SICSeG classification divides the pathology into types: A (acute) and B (chronic, with bone / bone and soft tissue injury).

Good long-term results of forearm bone dislocation correction after conservative treatment have been described; however, the outcome was poor in 10 % of patients, of which 2 % require surgical intervention, and approximately 8 % experience symptoms of post-traumatic instability of the elbow joint [8, 12].

Improvements in surgical techniques and technical progress have focused on minimally invasive interventions, while elbow arthroscopy is still technically challenging due to limited space and proximity of neurovascular structures. However, it is an effective treatment method that allows avoiding a wide range of complications: iatrogenic neuropathy (3.4%), superficial and deep wound infection (2.0% and 0.7%, respectively), wound healing complications (1.5%), joint contracture and instability (4.5% and 2.6%), and the need for revision surgery (4.1%). Patients are be able to begin rehabilitation and, as a result, recover faster than with open surgical approaches (overall complication rate is 52%; tunnel and contusion neuropathy of the ulnar and median nerves, pseudarthrosis of the ulnar or coronoid process, heterotopic ossifications) [13–18]. There have been no comprehensive studies of the consequences of forearm bone dislocations on a big sample of patients and with a large volume of data. Therefore, even a single episode is of academic interest.

Purpose The aim of the work is to present a clinical case of an effective combination of arthroscopic and minimally invasive surgery methods for reconstruction of the ligamentous apparatus in chronic posterolateral instability of the elbow joint.

MATERIALS AND METHODS

Patient H., 31 years old, a former professional snowboarder, came to an outpatient appointment with a trauma orthopaedist at the Novosibirsk Tsivyan Research Institute of Traumatology and Orthopaedics on November 3, 2023, complaining of pain, posterolateral instability of the left elbow joint, acoustic elements ("clicks"), transient blocks, and muscle weakness of the limb. History: primary organized sports injury (2006): fall on a straightened left upper limb while performing a sports element in a half-pipe.

Emergency medical care was provided to the patient outside the Russian Federation within 24 hours. Radiography of the left elbow joint was taken in two projections and the diagnosis was: acute complicated posterior dislocation of the bones of the left forearm with damage to the ulnar collateral and medial collateral ligaments of the elbow joint, non-tension hemarthrosis. Manual reduction was performed under local anesthesia with Sol. Novocaini 0.5 % 40 ml. There were no complications such as incongruence or fractures on checking X-rays. Subsequently, three episodes of dislocation of the bones of the forearm were detected (in 2011, 2018, 2023) and chronic PLRI of the left elbow joint developed. Clinical tests (without conduction anesthesia): O'Driscoll dynamic valgus stress test "+", O'Driscoll lateral pivot-shift test "–", Regan/Lapner "+", Pollock gravitational stress test "–". Morphometry: flexion/extension — 55/160°, pronation/supination — 80/45°. Strength was assessed with a mechanical dynamometer: Dex. 90; Sin. 65 (2daN). Given the contradiction in the targeted clinical tests, an instrumental examination was performed in the volume of 1.5 T MRI of the elbow joint that detected damage to the area of the "anatomical imprint" of the MULC/LCLC (Fig. 1). Additionally, a defect in the articular surface of the trochlea humeri and fossa olecrani, intraligamentary ossification of the MULC with provocation of the cortical layer of the medial epicondyle of the left humerus and LCLC, and exostosis of the olecranon of the ulna were visualized.

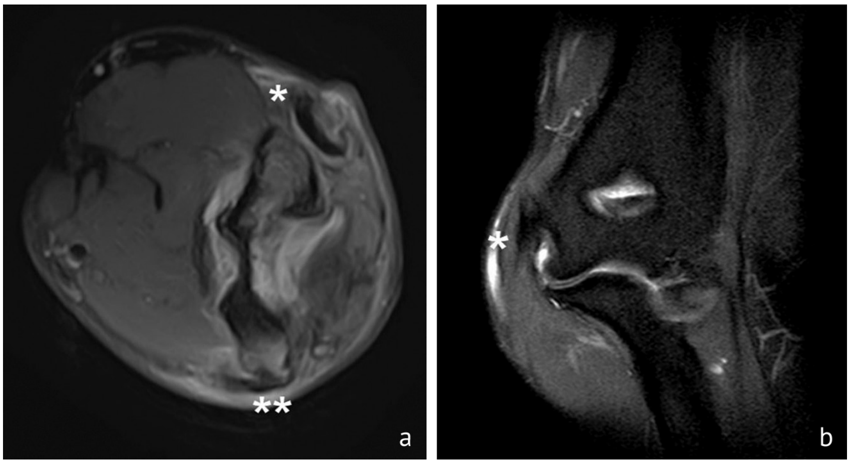

Fig. 1 Scans of the area of interest: post-traumatic instability of the elbow joint of the left upper limb in coronal (*a*) and sagittal (*b*) sections of T1-weighted MRI with measurement of the MUCL (*) and LCLC (**) the structures

Findings of orthopaedic questionnaires: VAS (Visual Analogue Scale) < 3, DASH (Disabilities of the Arm, Shoulder, and Hand) — 30.8; MEPS (Mayo Elbow Performance Score) — 45 points respectively; SF-36 (36-item Short Form Health Survey): physical condition — 25 %; physical health limitations — 0 %; limitations due to emotional state — 0%; energy/fatigue — 60 %; emotional well-being — 32 %; socialization — 50 %; pain — 45 %; general health — 25 %; change in health — 25 %.

SICSeG classification: type B, recurrent, bone + soft tissue; O'Driscoll classification: recurrent, radioulnar/humeral, PLRI, subluxation, coronoid process.

Anamnesis morbi: injury during domestic activities, chronic post-traumatic instability of the elbow joint for more than 17 years, left arm, non-dominant side.

On the day of hospitalization (03.11.2023), the following treatment was performed: arthroscopy of the left elbow joint, resection of pathological humeroradial folds; removal of chondral bodies; reinsertion of the radial collateral (RCL) and lateral ulnar collateral ligaments (LUCL); MUCL reconstruction with an autogenous graft of the split m. peroneus lon-gus; reinsertion with soft-tissue anchor fixators; debridement.

The patient was placed on the orthopaedic table in the prone position, with the arm abducted at 90° at the shoulder joint and bent at 90° at the elbow joint, in a hanging position. Before draping the surgical field, a pneumatic tourniquet was applied at the level of the upper third of the humerus, and the pressure was elevated to 250 mm Hg. Before using the incision film, anatomical landmarks were marked (medial, lateral epicondyles of the left humerus, olecranon of the ulna) marking the n. ulnaris and the main ports (proximal superomedial port, superlateral port, anteromedial port, anterolateral port, direct lateral port, posterocentral port) [19] (Fig. 2).

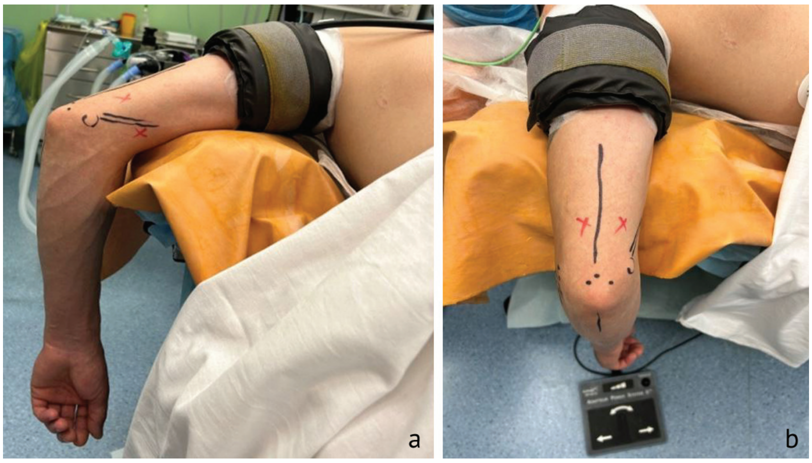

Fig. 2 Photo of the patient's position on the operating table with the application of a pneumatic tourniquet (*a*) and marks of the main ports (*b*)

The surgical intervention was performed under combined anesthesia: regional interscalene anesthesia (brachial plexus block from the supraclavicular approach with 0.5% Ropivacaine 20 ml under ultrasound navigation, stimuplex current 0.36 mA) in combination with intubation anesthesia.

Centesis of the elbow joint was performed via the standard anteromedial approach; revision revealed posttraumatic cubarthrosis grade 1–2, secondary chondromatosis of the trochlea humeri and fossa olecrani, and heterotopic ossification. O'Driscoll, Regan/Lapner, and Pollock "+" tests after the development of anesthesia confirmed PLRI. Lateral approach was performed under arthroscopic control, and articular surfaces were assessed with a manipulator. The hyaline cartilage was peeled off in some places. More than two chondral bodies were removed, sized approximately 3 × 2 mm. Cold plasma coblation of the enlarged synovial folds was performed (plical syndrome was resolved). An arthroscope was inserted via a separate posterior approach under the triceps into the cubital fossa area. The fossa was sealed and consisted of scar tissue and osteophytes. Debridement was performed using a shaver system and an ablator. Degeneration of the triceps tendon at the attachment site (foot print) was determined. The range of motion increased by more than 10–15° on average after elbow arthrolysis had been removed. A rupture of the MUCL with provocation of the cortical layer of the medial epicondyle of the left humerus and the RCL, degeneration of the radial head (chondromalacia stage 2) were visualized. Synovial folds were dissected.

Through a 1-cm skin approach in the area of the lateral malleolus of the left lower leg, the tendon of m. peroneus longus sin was isolated and extracted with an instrument; 2/3 was divided into two bundles and a 5 × 260 mm portion of the tendon was collected with an open pig tail extractor for subsequent preparation and formation of an autotenograft. In the medial compartment, the medial epicondyle of the humerus was visualized (Fig. 3 a; Fig. 4 a); n. ulnaris was retracted proximally in the cubital canal in order to prevent conflict and neuropathy and the cortical layer was processed with a drilling bur until "blood dew". Through a 5-mm approach, one anatomical soft-tissue anchor fixator, sized 2.7 mm, was implanted with immersion of the previously prepared autotenograft under arthroscopic control. The second anchor fixator, sized 2.7 mm, was installed distal to the incisura trochlearis.

The elbow joint was extended, and the radial collateral ligament formed from the graft was sutured and fixed in the position of maximum tension. In the lateral compartment, the lateral epicondyle of the humerus was visualized, the cortical layer was processed to the "blood dew" (Fig. 3 b; Fig. 4 b) and a 2.7-mm non-body soft-tissue anchor fixator was implanted in a similar manner; and a penetrator was used to perform transtendinous suturing of the radial collateral ligament using the "parachute" method and sliding knots were tightened in the neutral position of the elbow joint.

The repeated O'Driscoll 1/2, Regan / Lapner, Pollock "–" tests revealed the elimination of chronic PLRI of the elbow joint under image intensifier control. Sutures were applied to the skin. The left upper limb is immobilized with a sling bandage.

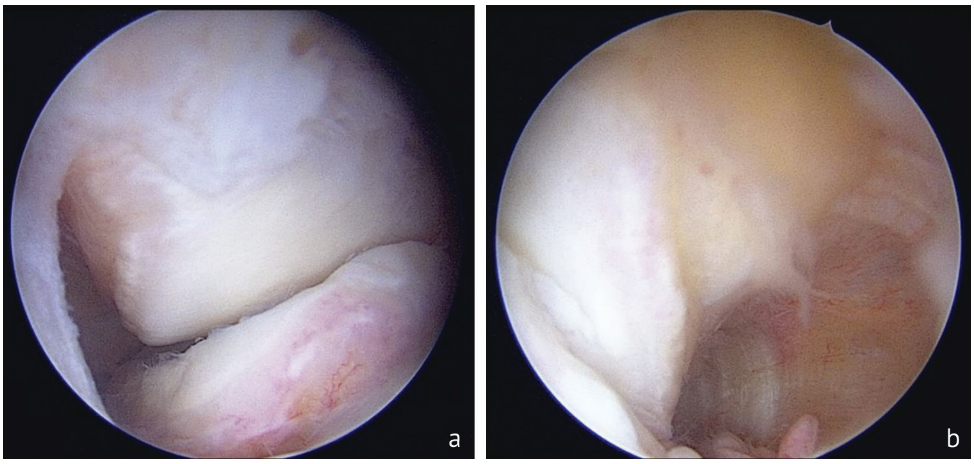

Fig. 3 Arthroscopic image through the posterocentral port with visualization of the provocation of the cortical layer of the medial epicondyle of the "anatomical impression" of the MUCL (*a*) and the disruption of the structures of the LCLC (*b*) during targeted clinical tests

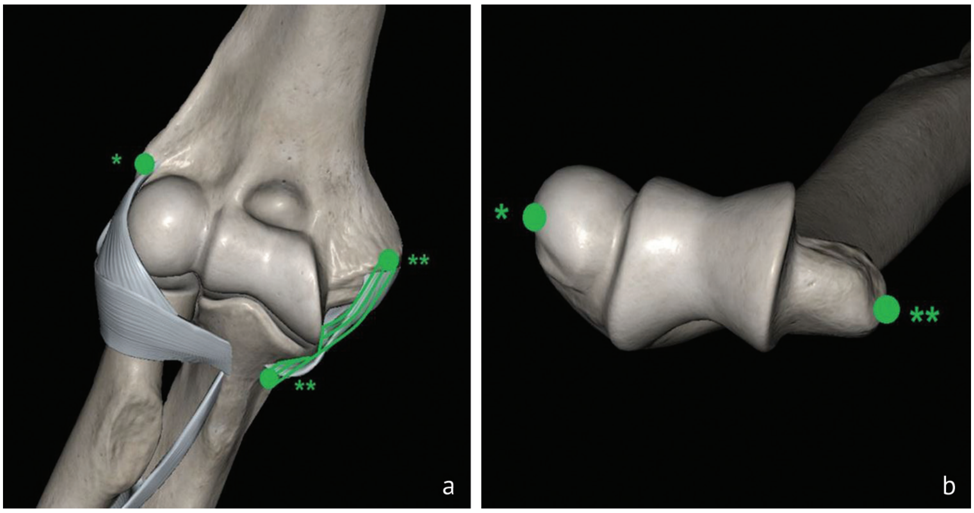

Fig. 4 3D model of the elbow joint (*a, b* visualization in different planes) with the location of the main reconstructive elements in the surgical treatment of chronic PLRI: anchor fixators for reinsertion (*) and autotenograft (**)

The patient was discharged on 05.11.2023 without signs of septic complications and was supervised by a physician of the outpatient department. The rehabilitation protocol included immobilization with a sling bandage for four weeks, cryotherapy (Kryotur), intake of non-steroidal anti-inflammatory drugs and muscle relaxants per os, and exercise therapy. In the first period, mechanotherapy of the elbow joint with some devices was recommended: manual kinesiotherapy, early passive movements from the second week (Kinetec Centura) and active movements from the fourth week. In the second period, exercise therapy under supervision of an instructor to restore complex motor stereotypes from the fifth week, limiting the axial and traction load (horizontal bar, parallel bars) on the upper limb for 12 weeks [3].

RESULTS

The results of treatment for chronic LRTI of the elbow joint by the method of arthroscopic reconstruction of the ligamentous apparatus were analyzed using a universal method of personalized assessment by questionnaire systems on an outpatient basis at the NNIITO after six and 24 weeks.

The absence of persistent pain, significant difference in the indicators of comparative dynamometry, O'Driscoll 1/2, Regan/Lapner, Pollock "-" tests were regarded as a positive result (Fig. 5).

Fig. 5 Photographic recording of the range of motion and targeted clinical tests of the left elbow joint after arthroscopic reconstruction of MUCL and reinsertion of LCLC in chronic PLRI of the elbow joint

First clinical examination (6 weeks): flexion/extension — 50/175°, pronation/supination — 90/90°, VAS 2, DASH 24.2, MEPS — 80 points respectively, SF-36: 60 %; 50 %; 66.7 %; 55 %; 64 %; 62.5 %; 77.5 %; 65 %; 50 %, dynamometry: Dex. 85; Sin. 90 (2daN),

Second follow-up examination (24 weeks): VAS 1, DASH 9.2, MEPS 95 and SF-36: 85 %; 75 %; 66.7 %; 70 %; 84 %; 75 %; 67.5 %; 80 %; 75 %, comparative ranges of motion corresponded to a healthy joint.

Postoperative complications were assessed after surgery at two control time-points. The first time-point was 45 days (12/18/2023): heterotopic ossification "–", neuropathy "–", contracture "+", muscle hypotrophy "+". The second time-point was 180 days (03/03/2024): heterotopic ossification "–", neuropathy "–", contracture "–", muscle hypotrophy "–".

Instrumental evaluation of the effectiveness: 1.5 T MRI of the affected joint with visualization of the course of the MUCL autotenograft to the "anatomical impression" (Fig. 6 a) and ligamentization of the RCL, absence of inflammatory changes, signs of ossification, heterotopic ossification (Fig. 6 b). The patient returned to everyday activities after 6 weeks and after 12 weeks to professional ones after completing the course of rehabilitation described above.

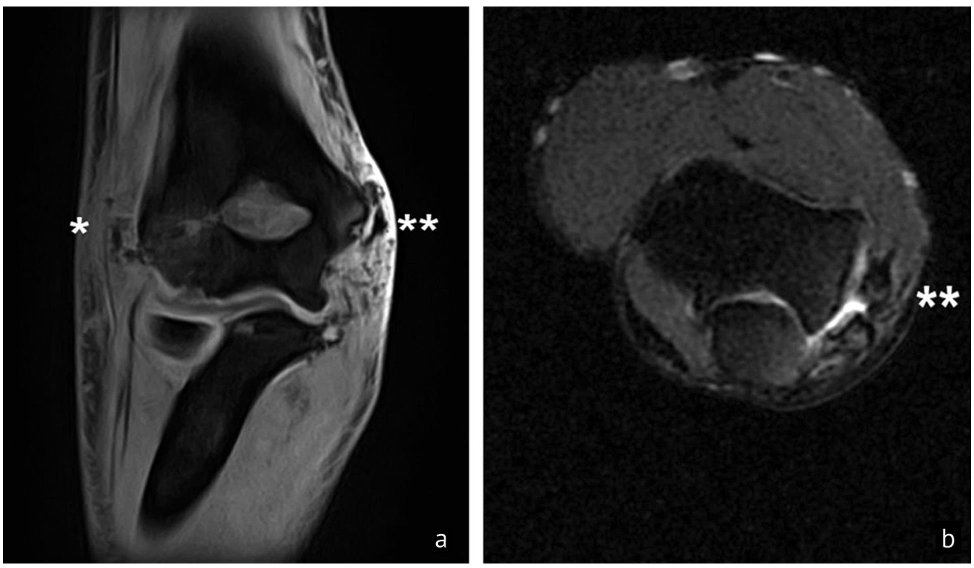

Fig. 6 MRI of post-traumatic instability of the elbow joint of the left upper limb in sagittal (*a*) and coronal (b) sections of the T1-weighted MRI mode, with visualization of the viability of the MULC autotenograft (**) and LCLC ligamentization (*) 6 weeks after surgical treatment

DISCUSSION

Outcomes of treatment in patients with uncomplicated dislocation of the forearm bones are usually favorable. However, studies show that 60% of these patients lose more than one bone or ligament stabilizer and may have residual symptoms: recurrent variant of post-traumatic instability of the elbow joint, joint contracture, pain associated with the development of degenerative processes, and transient ulnar neuropathy [4, 10, 20]. Available data on the incidence of complications leading to revision surgery average 12–15%, but they have limitations due to small cohorts of patients in most studies [14, 16].

Due to the fact that most injured patients are of working age, the problems of treating post-traumatic instability of the elbow joint and dislocation of the forearm bones, as well as subsequent rehabilitation measures, is of significant socio-economic nature. The clinical case presented is a case of successful arthroscopic treatment of ligamentous stabilizers of the elbow joint using an effective combination of implants in a posterolateral model of elbow instability. The technique is focused on the principles of minimally invasive reconstructive plastic surgery in order to restore the biomechanics of a large joint of the upper limb girdle and meets the objectives of careful treatment of soft tissues, allowing visualization of the damage and avoidance of contact with neuro-vascular structures. We have not found any publications about such experience in the domestic literature. Diagnostic and therapeutic arthroscopy is a generally accepted method of treating a wide range of elbow joint diseases. The rarity of the method is not dictated by its complexity or the presence of a large number of complications. The required experience of the surgeon, the level of qualification, knowledge of anatomy and biomechanics are determined by the complexity of clinical cases. The described technique, performed according to indications, seems to be effective in the treatment of patients with chronic posterolateral rotational instability of the elbow joint. However, a larger sample of patients with long-term follow-ups will certainly fully show its advantages and identify possible shortcomings.

CONCLUSION

The combination of arthroscopic and minimally invasive surgery in this clinical case avoids conflict with neurovascular structures, provides visual control of implantation of anchor fixators. The clinical case demonstrates a successful combination of arthroscopic and minimally invasive surgery methods for reconstruction of the ligamentous apparatus in elbow joint instability.

Conflict of interest *The authors report no obvious or potential conflicts of interest related to the publication of materials.*

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Informed consent *The patient voluntarily signed an informed consent for the publication of personal medical information in an anonymous form.*

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