CLINICAL CASE OF THE SURGICAL TREATMENT OF COMPLETE RUPTURE OF DISTAL BICEPS TENDON USING TWO CORTICAL BUTTONS

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ABSTRACT

Distal biceps tendon injuries mainly occur in men from the active groups of population. Among the athletes and military personnel, the incidence rate is 2–10 % of the upper limb tendon injuries. Comparative studies have shown the achievement of better functional results in surgical treatment, while maintaining overall complication rate of 4.6–25 %.

The aim. *To demonstrate a new reinsertion technique with two cortical buttons in case of complete rupture of distal biceps tendon as part of a clinical case.*

Materials and methods. *The article presents a clinical case of surgical treatment of a patient with complete rupture of dominant limb distal biceps tendon which was more than 2 weeks old and was accompanied by lacertus fibrosus provocation and persistent muscle retraction.*

Results. *We obtained the following clinical results by the week 24 after the surgery: VAS (Visual Analogue Scale) score – 1 cm, ASES (American Shoulder and Elbow Surgeons) score – 99 points, DASH (Disabilities of the Arm, Shoulder and Hand) score – 15 points. Dynamometry results: Dex. 85; sin. 90 (2daN); range of motion corresponds to the same of a healthy joint. MRI at 1.5 T shows no signs of synostosis or heterotopic ossification; MSCT shows no signs of migration of cortical buttons in comparison with intraoperative X-ray control.*

Discussion. *Extracortical methods of distal biceps tendon positioning in anatomical reinsertion have lower strength indicators, comparable with the use of transosseous sutures and anchor fixators. A larger area of contact of the studied zone in case of minimal tendon compression in the area of proximal radioulnar space or inside the formed radial bone canal provides high strength indicators and reduces the risk of repeated injury.*

Conclusion. *The scores of the scales (VAS, DASH, ASES) turned out to be better than when using other common methods. The technique of dipping distal biceps tendon stump into the formed oval canal of the "anatomical impression" using the proposed method meets the objectives of careful attitude to the tendon and provides the largest area of its contact with the bone.*

Key words: *elbow joint, lacertus fibrosus, distal tendon, biceps, sports medicine, cortical button*

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КЛИНИЧЕСКИЙ СЛУЧАЙ ХИРУРГИЧЕСКОГО ЛЕЧЕНИЯ ПОЛНОСЛОЙНОГО ПОВРЕЖДЕНИЯ ДИСТАЛЬНОГО СУХОЖИЛИЯ ДВУГЛАВОЙ МЫШЦЫ ПЛЕЧА С ПРИМЕНЕНИЕМ ДВУХ КОРТИКАЛЬНЫХ ПУГОВИЦ

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РЕЗЮМЕ

Введение. *Повреждения дистального сухожилия двуглавой мышцы плеча (ДСДМП) в основном встречаются у мужчин в активных категориях населения. Среди спортсменов и военнослужащих частота случаев составляет 2–10 % от сухожильных травм верхней конечности. Сравнительные исследования показали достижение лучших функциональных результатов при хирургическом лечении с сохранением общего уровня осложнений 4,6–25 %.*

Цель исследования. *Демонстрация новой техники реинсерции двумя кортикальными пуговицами при полнослойном повреждении дистального сухожилия двуглавой мышцы плеча в рамках клинического случая.*

Материал и методы. *Представлен случай хирургического лечения пациента с полнослойным повреждением ДСДМП на доминантной конечности давностью свыше 2 недель, провокацией lacertus fibrosus и стойкой мышечной ретракцией.*

Результаты. *Клинические результаты к 24-й неделе после операции по шкалам: VAS (Visual Analogue Scale) – 1 см, ASES (American Shoulder and Elbow Surgeons) – 99 баллов и DASH (Disabilities of the Arm, Shoulder and Hand) – 15 баллов. Динамометрия: Dex. 85; Sin. 90 (2daN); амплитуда движений соответствует здоровому суставу. Инструментальная оценка: магнитно-резонансная томография при 1,5 Тл – признаки синостозирования или гетеротопической оссификации не выявлены; мультиспиральная компьютерная томография – миграция кортикальных пуговиц в сравнении с интраоперационным рентген-контролем не выявлена.*

Обсуждение. *Накостные методы позиционирования ДСДМП при анатомической реинсерции имеют меньшие показатели прочности, сравнимые с таковыми при использовани трансоссальных швов и якорных фиксаторов. Бóльшая площадь контакта изучаемой зоны при минимальной компрессии сухожилия в области проксимального радиоульнарного пространства или внутри сформированного канала лучевой кости даёт высокие прочностные показатели и снижение риска повторного повреждения.*

Заключение. *Результаты шкал (VAS, DASH, ASES) оказались лучшими, чем при использовании иных распространённых методик. Методика погружения культи ДСДМП в сформированный овальный канал «анатомического оттиска» предлагаемой техникой отвечает задачам бережного отношения к сухожилию и обеспечивает наибольшую площадь его контакта с костью.*

Ключевые слова: *локтевой сустав, lacertus fibrosus, дистальное сухожилие, бицепс плеча, спортивная медицина, кортикальная пуговица*

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INTRODUCTION

Injuries to the distal biceps brachii tendon (DBBT) are mainly found in active males, with an incidence of 1.2–5.4 cases per 100,000 in the general population [1]. Among athletes and military personnel, the incidence ranges from 2–10 % of tendon injuries of the upper extremity [2]. As a consequence of spontaneous eccentric action on the flexed elbow joint – forearm supination – strength and endurance can be reduced by more than 40 %, while constant tension on the degeneratively damaged *lacertus fibrosus* or DBBT stump can lead to persistent pain syndrome [3]. Injuries are more frequent in males (> 95 %) than females (≤ 5 %); the mean age of those addressing is 46.3 years [4]. In sport, nosology affects younger categories at the peak of their career (38.3 years) [5].

The pathogenesis of the focal degenerative processes formation as a result of DBBT hypovascularisation during mechanical impingement accompanying forearm bone rotation continues to be mentioned in the literature as the main cause of damage in the area of the "anatomical impression" on the radial tuberosity. Histopathological findings of the injured area revealed increased proteoglycans, collagen type III, matrix metallopeptidase-1 and matrix metallopeptidase-3, indicating pre-existing tendinopathy [6]. Besides, abuse of anabolic androgenic steroids (androstane and estrene derivatives), corticosteroids, statins (HMG-CoA reductase inhibitors) leads to an increased risk of degenerative processes in the enthesis area [7].

There is an evidence that > 26 % of professional athletes are unable to return to their usual level of exertion after DBBT injury, whereas > 89 % of injured patients from physical labour can recover complex motor patterns in postoperative work [5]. Numerous comparative studies have shown better functional results with surgical treatment of this type of injury (acceleration of strength and endurance indices) compared to a conservative approach.

The emphasis of surgical techniques is now shifting towards minimally invasive anatomical reinsertion, allowing not only the restoration of flexion and supination strength, but also the avoidance of desmogenic contractures. The overall post-treatment complication rate, however, is still in the range of 25 % which is associated with the complex architectonics of the neurovasal structures of the *fossa cubiti* [8]. Heterotopic ossification and synostosis of the proximal radioulnar space (PRUS) are common with the "classic" Dobbie access or the "minimally invasive" Boyd – Anderson access. Systematic reviews also report ≥ 5 % posterior interosseous nerve injuries (PIN), lateral antebrachial cutaneous nerve injuries (LABCN) ≤ 40 % in common surgical approaches [9–11]. The alternative DBBT repair technique of anterior double incision approach (ADIA) has recently gained popularity due to its low postoperative complication rate. Reinsertion methods have also evolved – from transosseous suture to complex variants of "anchor" fixation, which are conceptually divided into the following groups: 1) extramedullary and intracanalicular (by DBBT position); 2) intramedullary and extramedullary (by implant positioning).

According to a series of topographic-anatomical studies by S. Siebenlist et al. the maximum strength values of DBBT fixation in the area of "anatomical impression" under cyclic loads are possible only with anatomical reinsertion of DBBT with a cortical button [12]. A single intramedullary cortical button can withstand forces of 275 ± 44 N at break, two intramedullary buttons 455 ± 103 N, and one extramedullary button 305 ± 27 N (the common Bain method), while anchor type and ligature fixation ("bone tunnels") can withstand 180 ± 20 and 150 ± 20 N, respectively. As a consequence, the strength performance of intracanalicular fixation permits aggressive postoperative rehabilitation protocols and allows for shorter periods of disability. Recurrent DBBT damage incidence remains rare (0.7 %), but the risk increases 7-fold (5.4 %) when a combination of implants (cortical button + interference screw) is used and a greater fixation strength is sought [8, 9].

This study is based on an earlier biomechanical study by S. Siebenlist et al. and consists of the fact that extramedullary methods of DBBT reinsertion in the area of the "anatomical impression" have lower strength values comparable to those of transosseous sutures or anchor fixators; therefore, it is still relevant to develop an effective implant combination for the intracanalicular variant.

The **aim** of this clinical case presentation is to demonstrate a new technique of reinsertion with two cortical buttons (hereinafter referred to as RTB) for a full-thickness injury of the distal biceps brachii tendon.

MATERIAL AND METHODS

Patient M., 44 years old, engaged in physical labor, went for an outpatient appointment with an orthopedic traumatologist at the Novosibirsk Research Institute of Traumatology and Orthopedics n. a. Ya.L. Tsivyan on October 16, 2022 with complaints of pain, deformity of the biceps muscle, presence of a spilled hematoma and muscle weakness. Clinical tests: Ruland "+"; O'Driscoll "–"; subcutaneous defect by reverse Popeye type (Fig. 1). Morphometry: flexion /extension 40°/90°; pronation/supination 50°/45°; palpable stump of distal biceps tendon at the level of the tendon-muscular junction. Assessment of force by mechanical dynamometer: Dex. 35; Sin. 90 (2daN). After clinical examination, magnetic resonance imaging (MRI) at 1.5 Tesla of the elbow joint was performed, revealing a full-thickness DBBT lesion.

Additionally, *lacertus fibrosus* provocation and muscle retraction (45 mm), the size of the PRUS (4.8 mm) were visualized (Fig. 2). Orthopedic scales survey: VAS (Visual Analogue Scale) – 5 cm; ASES (American Shoulder and Elbow Surgeons) – 30 points; DASH (Disabilities of the Arm, Shoulder and Hand) – 49 points. Classifications: type 3 according to L. Perera and type 3b according to J. Fuente. Anamnesis morbi: work-related injury; prescription of injury < 3 weeks; right hand, dominant side. A topographic-anatomical study on cadaveric material was performed be-

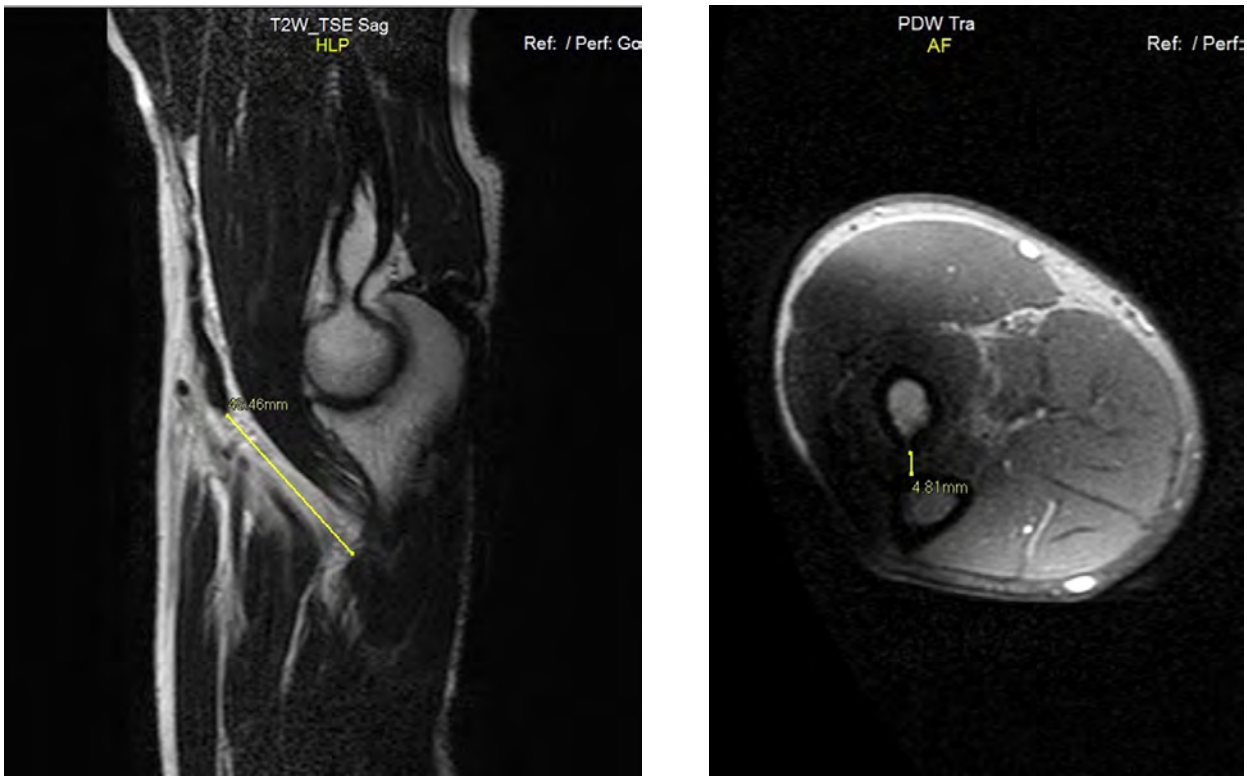
a ***b***

FIG. 1.
*Patient M. Specific O'Driscoll test "–" (**a**) and Ruland test "+" (**b**) in case of complete rupture of distal biceps tendon*

fore surgical treatment in clinical practice in 2022. The obtained results made it possible to perform calculations of the DBBT contact area on the radial tuberosity for different reinsertion methods. With the consent of the ethical committee of February 2023 Novosibirsk Research Institute of Traumatology and Orthopedics n. a. Ya.L. Tsivyan, an article was published and a patent for the invention of surgical technique was received [13, 14]. The patient has signed an informed voluntary consent (IVC) for the medical intervention, as well as an IVC for the release of personal medical information in an anonymized form. RTB treatment was performed on the day of admission on October 24, 2022.

Surgical intervention was performed under combined anaesthesia: regional intercostal anaesthesia (brachial plexus blockade from supraclavicular access with Ropivacaine 0.5 % – 20 ml) combined with intubation anaesthesia.

Laying the patient on the orthopaedic table in the supine position with the arm resting 90° at the shoulder joint on an attachment shelf. Strict forearm supination in the elbow extension position was monitored throughout the session. Anatomical landmarks were labelled before using the incision film under the X-ray guidance of an electron optical converter (EOC): DBBT stump, proximal "search" and distal "main" access (ADIA), radial head and *n. radialis* marking. A 3 cm transverse skin incision was made on the palmar surface at the marking site in the projection of the radial tuberosity. In the interval between *M. brachioradialis* and *M. pronator teres*, *N. radialis* was visualized and moved to the lateral side for free skeletonization of the "anatomical impression". A 2 mm Kirschner spoke (hereinafter referred to as a guide spoke) was positioned through the upper edge of the radius tuberosity by means of power equipment. Then, a through channel was drilled using a 4.5 mm bone drill along the guide spoke. Following 2 cm distally, which corresponds to the lower edge of the radius tuberosity, the second guide spoke was inserted in a similar manner with the sequential formation of a 4.5 mm through channel. Keeping the guide spokes in place, the bone drill was changed to 7 ± 2 mm and the palmar cortical layer of the radius was drilled out to form a blind-ended oval hole. Subsequently, a 2 cm longitudinal skin incision was made in the lower third of the upper arm above the area of the retracted DBBT stump. The isolated stump was sutured with nonabsorbable thread (gauge 5 Ti-Cron, braided tape variant) according to the Krackow method for 3–4 cm. A partial lesion of the *lacertus fibrosus* was revealed in the distal parts of the residual limb, which required suturing. The free ends of the nonabsorbable thread were inserted into the first cortical button to form a self-tightening loop. Between the ADIA access "windows", the stump was guided through the myofascial canal formed with the Mikulich clamp to the "anatomical impression" (Fig. 3). A second cortical button was then tak-



a ***b***

FIG. 2.

*Patient M. Patient M. T1-weighted MRI in case of complete rupture of distal biceps tendon in sagittal (**a**) and coronal (**b**) sections, with measurement of the proximal radioulnar space the level of middle third of the tuberosity anatomical impression of the right radial bone and of the muscle retraction degree*

a ***b***

FIG. 3.

*Patient M. Stump suturing with lacertus firbrosus suture (**a**) and passage of the restored complex between the "windows" of anterior double incision approach (ADIA) (**b**)*

en and a free nonabsorbable thread was inserted into it to form a similar self-tightening loop. Through the distal skin incision, a medical instrument (e. g., Mosquito clamp) was used to insert the first cortical button in an upright position through the distal through channel in the cortical layer of the radius; the free ends were left outside.

A second cortical button was inserted through the proximal through channel in a similar manner. Both cortical buttons were placed in a horizontal position by the rotation method with mandatory EOC control. The elbow joint of the operated extremity was brought to the 60–90° flexion position, and the DBBT was lowered with self-tightening loops into the formed oval opening of the radial tuberosity. The achieved correction was fixed with 3–4 locking knots. A uniform immersion of the DBBT stump with the repetition of the "anatomical impression", a high degree of fixation strength and a larger area of tendon-bone contact were visually observed compared to the known methods. Surgical wounds were sutured and aseptic dressings were applied. The operated limb was not immobilized. Intraoperative EOC monitoring was supplemented within 1 day by multilayer spiral computed tomography (MSCT) with 3D reconstruction to exclude splitting of the bony "isthmus" between the 4.5 mm technical canals and migration of cortical buttons (Fig. 4).

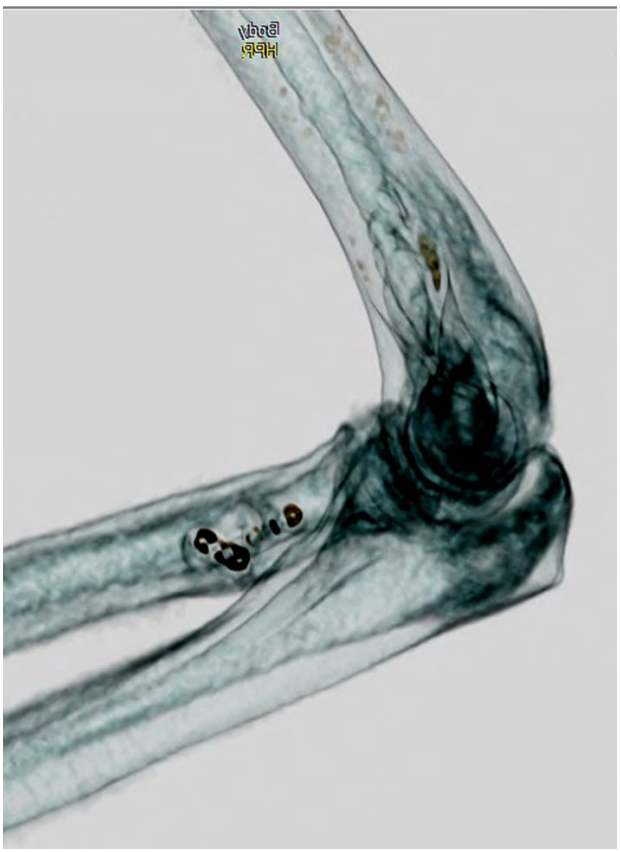
The patient was discharged under the supervision of an outpatient unit doctor on October 28, 2022, there were no signs of septic complications. The rehabilitation protocol included immobilization with kinesiotape (sequential change of stabilizing and lymphatic drainage variants every 5 days for 4 weeks), cryotherapy, non-steroidal anti-inflammatory drugs *per os*, physical therapy – I period, apparatus mechanotherapy on the Kinetec Centura training appliance (Kinetec, France).

RESULTS

The results of treatment of full-thickness DBBT lesions with RTB technique were analysed using a universal method of personalized assessment by questionnaire with the use of scales (VAS, DASH, ASES), the first of which was conducted on an outpatient basis at the Novosibirsk Research Institute of Traumatology and Orthopedics n. a. Ya.L. Tsivyan after 6 weeks, the second – after 24 weeks. The absence of persistent pain syndrome (VAS < 2 cm), statistically significant difference in comparative dynamometry, Ruland and O'Driscoll tests was considered as a positive result (Fig. 5).

Initial clinical examination: flexion/extension 10°/120°; pronation/supination 80°/70°. Second follow-up exami-

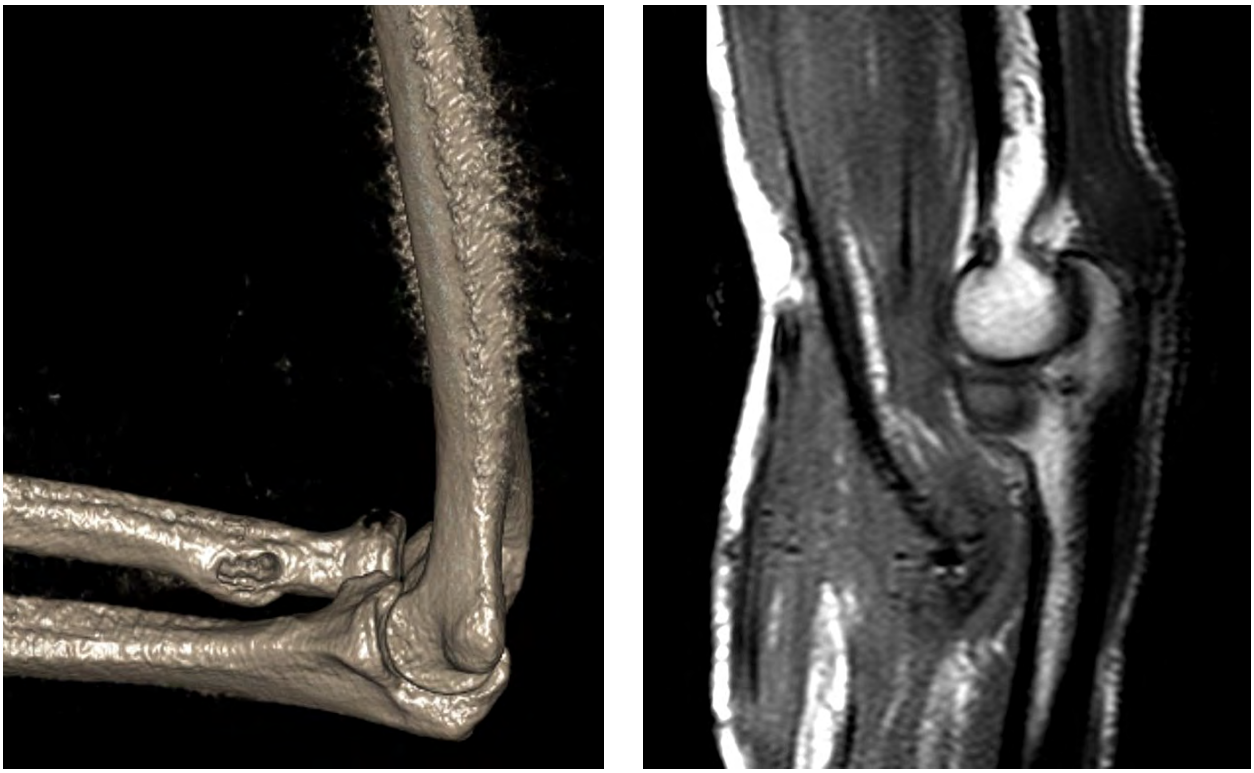
a



b

FIG. 4.

*Patient M. Intraoperative X-ray imaging of the operated elbow joint under the control of the light image converter (**a**) and multispiral computed tomography with 3D visualization of the cortical implants position 6 months after surgery using reinsertion with two cortical buttons (**b**)*



a ***b***

FIG. 5.

*Patient M. Multispiral computed tomography with 3D visualization of the "anatomical impression" (**a**) and MRI visualization of tendon tension (**b**) 6 months after surgical treatment using reinsertion with two cortical buttons*

nation (24 weeks): VAS – 1 cm, ASES – 99 points, DASH – 15 points. Dynamometry: Dex. 85; Sin. 90 (2daN); comparative movement amplitudes correspond to a healthy joint. Postoperative complications were assessed at two postoperative checkpoints. First point – 30 days: heterotopic ossification "–", neuropathy "–", contracture "+", muscle hypotrophy "+". Second point – 90 days: heterotopic ossification "–", neuropathy "–", contracture "–", muscle hypotrophy "–". Instrumental assessment of the results: 1.5 Tesla MRI of the operated joint with visualisation of the tendon course to the "anatomical impression" – absence of inflammatory changes of the *lacertus fibrosus*, previous size of the PRUS (4.8 mm) without signs of synostosis or heterotopic ossification; MSCT with 3D reconstruction – absence of cortical button migration in comparison with intraoperative EOC-control.

The patient returned to domestic activities after 4 weeks and to occupational activities after 6 weeks of the above rehabilitation.

DISCUSSION

Extramedullary methods of DBBT positioning during anatomical reinsertion have lower strength values comparable to the use of transosseous sutures and anchor fixators, even with the intramedullary use of one or two cortical buttons proposed by S. Siebenlist et al. [12, 15]. Comparative measurements of the tendon-bone contact index at the radial tuberosity revealed an advantage of intracanal methods (2.09 ± 0.2 cm^2) over extramedullary methods (0.49 ± 0.2 cm^2) in a recent topographic-anatomical study [14]. The large contact area of the study area with minimal compression of the tendon in the area of the PRUS or inside the formed radial canal ensures that high strength values are achieved and the risk of re-injury is reduced. Similar DBBT fixation methods accompanied by technically complicated *lacertus fibrosus* sutures or additional use of an interference screw are also available from the literature, which have risks of high intracanalicular compression and ischaemia, as well as direct traumatization of the degeneratively changed tendon by the implant blades [16].

A case of successful surgical treatment of a full-thickness DBBT lesion using a new technique with effective use of implants is described in this clinical observation. The technique of immersing the DBBT stump into the formed oval canal of the RTB "anatomical impression" meets the objectives of gentle treatment of the tendon and has the largest area of contact with the bone. No publications about such an experience were found in the foreign and domestic literature.

CONCLUSION

The vast majority of full-thickness DBBT lesions are treated surgically, while the incidence of periopera-

tive complications and re-injury varies widely depending on the specific technique and patient demographics. The choice of cutaneous access and reinsertion method continues to be the question that's been debated a lot in the search for universal solutions. The RTB technique, performed as suggested, is effective in the treatment of the full-thickness variant of the lesion, but a longer time frame and number of observations will reveal the advantages and disadvantages, thus determining its place in clinical practice.

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Conflict of interest

The authors of this article report the absence of obvious and potential conflict of interests related to the publication of materials.

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