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Optimizing the Effectiveness of Treatment For Injury of the Distal Tendon of the Biceps Braipii Muscle

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Annotation: The presented review is devoted to a topic whose relevance is beyond doubt and is determined by the lack of a unified concept for the treatment of patients with damage to the distal biceps tendon. Treatment concepts for this rare nosological form will remain a topic of debate. Despite the availability of a sufficient range of technologically advanced and modern systems for fixing the tendon and restoring the function of the damaged limb, orthopedic traumatologists have a desire to improve the proven technique and rethink the optimal method.

Keywords: tendons, muscle, shoulder, injury, treatment.

Relevance. According to the literature, injuries to the biceps brachii muscle in 96% of cases are represented by injuries to the long head, in 3% to the distal tendon, and in 1% to the short head. These injuries are usually observed in male patients aged 30 to 60 years on the dominant limb. Risk factors include smoking, obesity and the use of anabolic steroids, long-term use of statins [2, 4, 9, 16]. The mechanism of injury is represented by the eccentric action of a tensile force with the elbow joint bent to approximately 90° and experiencing an extension effect. Moreover, if damage to the long head occurs mainly as a result of indirect trauma (87.3%), then damage to the distal tendon is quite common due to direct exposure to a traumatic factor (34.8%) [18, 14, 15]. The etiology and pathogenesis of distal biceps tendon injury (DBTI) is still unclear. A number of generally accepted theories converge on two mechanisms – the presence of a hypovascular zone and a mechanical mechanism as the cause of damage to the DBTI [8, 9, 12]. To understand these mechanisms, Seiler et al. performed anatomical and radiological examination [4, 9]. The anatomical part of the study was carried out on cadaveric elbow joints with visualization of blood vessels. Based on the analysis of the results obtained, the authors found confirmation of the theory about the presence of a hypovascular zone of the tendon approximately 2.15 cm long in the central zone of the tendon. This can lead to degenerative changes in the tendon due to repeated microtrauma. The radiological part of the study consisted of performing a computed tomography scan of the forearm tissues in the position of maximum supination, neutral position and maximum pronation. It was found that in the position of maximum pronation of the forearm, the distance from the ulna to the tuberosity of the radius, 13 in the space of which the studied tendon is located, was 48% less than this distance in the position of maximum supination. In addition, in the position of maximum pronation of the forearm, the DBTI occupies up to 85% of the interosseous space, undergoing impingement without static and dynamic forces of the surrounding muscles, which, in all likelihood, is the cause of damage to individual fibers. Histopathological studies of the injured area show in the tendon stump and radial tuberosity an increased content of proteoglycans, collagen type III, matrix metallopeptidase-1 and matrix metallopeptidase-3, disorganized fiber arrangement, which may indicate previous bursitis or tendinopathy [8]. Taken together, the dynamic change in the PRUP and the variability of the anatomical impression under cyclic loads contribute to the formation of a zone of hypovascularization and hypooxygenation of the DBTI tissue, which is a secondary cause of degenerative damage [4, 10]. Thus, surgeons should avoid extraosseous positioning of the tendon stump, which is typical for methods using anchors and ligature fixators, both during primary and revision reinsertion [2, 4]. Thus, trophic disorders as a consequence of hypovascularization and hypooxygination of tendon tissue may be the cause of subsequent degenerative damage to the anatomical formation, and the mechanical theory has been proposed as a second mechanism of damage to the DBTI.

The current classifications of DBTI are based on identifying the amount of damage to the cross-section of DBTI fibers (more or less than 50%) using instrumental methods, determining the degree of muscle retraction and the involvement of the biceps aponeurosis (lacertus fibrosus). In 2012, L. Perera et al. proposed to divide DSD injuries into 4 types [18]: type 0 – intact distal biceps brachii tendon; Type I – partial damage to the distal biceps tendon; Type II – combined damage (avulsion) of the short and long heads of the distal tendon of the biceps brachii muscle, the biceps aponeurosis is intact, muscle retraction is minimal; Type III – combined damage to the distal tendon of the biceps brachii muscle and biceps aponeurosis, moderate muscle retraction; Type IV – combined damage to the distal tendon of the biceps brachii muscle and the biceps aponeurosis, severe muscle retraction; The classification provides explanations not only for the anatomical deviations of DBTI, but also provides clinical recommendations for treatment methods corresponding to each stage of the process. One of the most popular for operating clinicians at the moment is the diagnostic classification of DBTI, proposed by J. Fuente et al. in 2018 [77]: type 1 – intact DBTI; MRI – no damage detected; Ultrasound: thickened, hyperechoic with a violation of the direction of the fibers, the tendon can be traced to its anatomical impression, without signs of damage in static and dynamic modes: 1a - changes are recorded on one (short or long) head; 1b – changes are recorded in the thickness of the united tendon on both heads (short and long); Type 2 – partial damage to the DBTI; MRI – partial damage; Ultrasound: thinned, low-lying contour, anechoic signal of the anatomical impression area, partially interrupted tendon, partendinal edema; 2a – intermittent signal of the anatomical impression area, thinning by ≥50% of the tendon thickness; 2b – intermittent signal of the anatomical impression area, thinning by >50% of the tendon thickness; 2c – intermittent signal in the area of the anatomical impression, damage to one of the heads (short or long) with retraction. An artifact in the form of a stump is visualized; type 3 – hypertrophy of the proximally located stump of the DSD, serpentine pattern in the sagittal plane, absence of fibers in the anatomical impression area, partendinal edema; MRI – full-thickness damage to the DBTI; 3a – hypertrophy of the biceps aponeurosis with minimal retraction of the DSD (≤8 cm); 3b – damage to the biceps aponeurosis with pronounced retraction of the DSD (>8 cm); Both classifications play an important role in structuring the approach to the study of rare pathologies and can serve as part of a future algorithm for choosing a treatment method in the presence of any instrumental diagnostic method widely available to specialists [5, 6, 14, 17].

Conservative treatment, according to the literature, is of limited value for damage to the DSD [1, 2, 3, 4, 5, 7, 15]. Thus, in the work of R.P. Dobbie presented the successful results of conservative treatment of 51 patients with damage to the DSD and put forward the following thesis: "it is impractical and unwise to choose a procedure that is more complex, dangerous and time-consuming when the same result can be obtained with less effort and without the risk of serious complications" [7,6]. However, these were elderly patients with low requirements for physical activity or exposed to risk factors that limit indications for surgical treatment. More recent studies by I. Hetsroni et al. show that unrepaired avulsions of the DSD often cause significant weakness in forearm flexion and supination. The literature presents subjective and objective results of surgical intervention, which exceeded the results of conservative measures to restore the strength of flexion in the elbow joint by 30%, supination by 40% and in terms of limb endurance (isokinetic test) [12]. In a retrospective study, C.R. Freeman et al. evaluated 18 patients with unrepaired avulsions of DSD over a period of 51 months. from the moment of its damage (conservative group) and comparing them with patients who underwent surgical restoration of the integrity of the DSD (surgical group) [8,9]. The assessment was carried out using the

DASH (Disabilities of the Arm, Shoulder and Hand) scale. Supination and flexion of the injured limb in patients of the conservative group were 74% and 88%, respectively, compared with these functions of the contralateral arm. Only one patient developed contracture of the elbow joint, which interfered with recovery; the rest were able to restore their previous level of ability to work within 12 weeks. A comparison was made with patients in the surgical group, in whom supination was restored as a result of the intervention, but deficits in elbow flexion remained in the early postoperative period; however, all patients recovered within 6 weeks. It is worth noting that the level of work ability in patients of the first group turned out to be higher than in operated patients (results ranged from 10 to 50 points). This allowed the study authors to conclude that a conservative treatment method for damage to the DSD may still be successful in patients presenting with acute trauma. The goals of conservative treatment are to reduce swelling and relieve inflammation, early restoration of range of motion with a subsequent (but secondary!) increase in muscle strength. For such patients, losses in forearm supination volume (40–50%) and flexion strength (30%) are predicted [4, 6]. The program of current conservative treatment includes immobilization with a scarf or hinge-type orthosis, an orthopedic regimen and combined use of NSAIDs, methods of autologous bioregeneration (ACP, PRP), as well as lymphatic drainage and stabilizing kinesiotaping during the period of active functional rehabilitation. Some authors actively debate conservative treatment in cases of partial damage, which may include a loss of less than 50% of the cross-sectional area of the DSD, which, in turn, leads to high functional indicators of the patient with adequate and timely therapeutic activity. However, the same patients in 76% of cases claim that the treatment was not effective enough [5, 8]. Meta-analyses by M. Cuzzolin et al. in 2021 and A.M. Looney et al. in 2022 they talk about the same results and similar satisfaction with conservative treatment [15]. In the area of rehabilitation treatment, when assessed using the International Classification of Functioning (ICF), the reason for these outcomes becomes clear and measurable: given the increased need to perform more different tasks (than in 1980), the overall assessment of upper limb functioning is significantly reduced, to the point of requiring additional working with a psychologist [8]. Data on the preferred treatment in the form of surgical reinsertion in 2021 were confirmed by the British Surgical Society British Elbow and Shoulder Society and other researchers confirming the need for mandatory MRI diagnostics as the most accurate diagnostic and reference tool in decision making [4, 8, 9].

Thus, according to the literature, the conservative method of treatment for damage to the DSD is mainly applicable in patients with intellectual work and in patients who have contraindications to surgical intervention due to their somatically unfavorable status. Patients in this group do not use forced flexion and forceful supination during work activity. Conservative treatment involves temporary immobilization, symptomatic therapy, physiotherapeutic and rehabilitation measures. There is a possibility of residual effects in the form of chronic pain syndrome, muscle wasting and desmogenic contractures, but with the help of secondary rehabilitation a satisfactory result can be achieved. In foreign literature, the advantages of anatomical reconstruction of the DSD injury (reinsertion to the anatomical impression of the radial tuberosity) relative to non-anatomical reconstruction (transposition and fixation of the DSD injury to the brachial muscle) are actively discussed [11, 16, 17, 19]. In a study by A. Klonz et al. In 14 patients who underwent anatomical and non-anatomical reconstruction of the DSD, isokinetic muscle testing was performed to assess the functional results of treatment. In 6 patients who underwent anatomical reconstruction, flexion and strength were restored in comparison with the contralateral limb by 96%, supination by 91%. In the 8 patients who underwent non-anatomical reconstruction, flexion and strength were also restored by 96% and supination by 42%. The authors did not encounter complications of neurovasal structures and radioulnar synostosis, however, heterotopic ossification developed in 4 patients who underwent anatomical reconstruction [13]. Thus, we can conclude that at present there are no clear recommendations on the choice of a specific method for reconstructing the DSD. Standard access proposed by R.P. Dobbie and J.M. Meherin, involves extensive incision of the elbow bend with good visualization of the soft tissue formations of the forearm, while the minimally invasive approach proposed by H.B. Boyd and L.D. Anderson, allows you to perform the main stages of manipulation through two small approaches in the projection of the tendon avulsion and the site of its attachment [4, 5, 14]. The minimally invasive approach was proposed in response to the high complication rate of nerve injury with the standard approach. H.B. Boyd and L.D. Anderson showed that surgical intervention using a minimally invasive approach (two incisions) reduces the likelihood of contact with neurovasal structures and allows reinsertion to be performed exactly in accordance with the anatomy. This technique involves cutting a section of the interosseous membrane and creating a bone canal in the radius for secure fixation. Following several reports that the minimally invasive approach results in heterotopic ossification and radioulnar synostosis, J.M. Failla described modification of H.B.'s access. Boyd and L.D. Anderson. His technique was characterized by less fiber disarticulation of the extensor muscles and limited skeletonization of the anatomical impression area [2]. Subsequent studies using the minimally invasive approach showed promising results [4]. A large number of studies reflect the positive results of using minimally invasive access, but some publications reflect complications that confirm the thesis that the access is not ideal. So, B.M. Katzman described posterior interosseous nerve palsy that developed after surgery [15]. P.R. Chavan et al. presented a systematic review of the literature on the results of surgical treatment of 142 patients with damage to the DSD using a minimally invasive approach. Complications were identified in 16%, the leading place among which was occupied by the mechanical component - limitation of rotational movements, in particular supination, and decreased strength of the forearm muscles. Interestingly, heterotopic ossification was regarded by the authors as a complication only in the presence of pain or movement deficit of more than 30° [6]. In contrast to the minimally invasive approach, S. Lintner and T. Fischer published the results of a study in which 5 patients with DSD damage underwent surgical treatment using a classic approach and fixation of the tendon with an anchor suture [17]. Upon follow-up of the patients for two years, it was found that all had recovered range of motion compared to the contralateral limb, there were no signs of neuropathy, and there were no signs of heterotopic ossification on radiographs. All patients returned to exercise within five months after their surgical treatment.

Along with the active discussion of the optimal surgical approach to the damaged DSD, methods of its fixation are also discussed [6, 7, 18, 16, 19]. S.A. Hasan, C. L. Cordell et al. conducted a biomechanical comparison of intact and operated DBTI using two methods of fixation: an interference screw and a transosseous suture on cadaveric material. There were no significant differences in the criteria for strength and durability of fixation of the intact tendon with a fixed interference screw, while the transosseous suture turned out to be less strong at the site of reinsertion [10]. And finally, an analysis of the data provided by P.R. Chavan et al., showed the greatest strength under loads on a DBTI fixed with a cortical button [6, 18]. E.A Mamatov et al. Specialists paid close attention to modern possibilities for treating intra-articular fractures of the humeroradial joint and the effectiveness of bioabsorbable fixators, which can be complicated by osteoarthritis of the elbow joint (hereinafter referred to as cuarthrosis), and, as a consequence, cause damage to the DSD [15]. Specialists interested in studying injuries to the elbow joint are especially attracted to the works of A.P. Ratyev in the field of study and treatment of osteoarthritis of the elbow joint and tendon-muscular injuries in this area following the primary dislocation of the bones of the forearm and complicated by the development of chronic instability of the joint [18, 19]. The complexity and variability of the location of the radial nerve along the shoulder, types of transposition of the triceps tendon during dislocations of the elbow joint, as well as the correctness of tendon sutures can be found in the latest topographic-anatomical works of A.S. Zolotov [7]. Of particular value is the work on the projection anatomy of the radial nerve using ultrasound [8]. Works by S.A. Linnik et al. in the field of studying minimally invasive osteosynthesis in patients with severe combined trauma and polytrauma, they provided insight into new possibilities of fenestrated approaches, including to the fossa cubiti area [14]. Advanced technologies that can determine the future vector of development of the work of practicing traumatologists, such as 3D printing, in the treatment of patients with injuries and diseases of the forearm, as well as a detailed analysis of domestic inventions for the surgical treatment of diseases and injuries of the shoulder joint were given by V.V. Khominetz et al. [22].

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