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Surgical treatment of distal biceps brachii tendon rupture: methods of fixation and rehabilitation. Experience with 20 patients

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Distal biceps brachii tendon ruptures are relatively uncommon injuries with numerous surgical exposures and methods of fixation offered for repair. The goal of surgical management is to restore the anatomic footprint of the biceps tendon on the radial tuberosity. Distal biceps fixation techniques include the use of bone tunnels in the bicipital tuberosity, tendon fixation with interference screws and cortical button that are competitive with alternative methods of suture anchors and transosseous sutures. Amplification of technical surgical aspects allows for a safer procedure, more aggressive postoperative rehabilitation and reduced recovery period for the elbow joint. **Objective** The purpose was to present the clinical experience and compare methods of fixation of tendon ruptures in terms of their advantages and disadvantages, implants' effect on postoperative function recovery in a group of patients followed for three years. **Material and methods** A retrospective review included 20 patients with distal biceps brachii tendon ruptures that required surgical treatment. **Results** Positive outcomes were achieved in 19 cases (95 %). Disability period was 33.5 ± 0.5 days in a group of intellectual workers and 45.5 ± 0.71 days in physically active patients or sportsmen. **Conclusion** The findings showed advantages of combined tendon fixation with cortical button and biodegradable interference screw. The results of treatment were shown to rank more than twice over those achieved with suture anchors and transosseous sutures.

Keywords: elbow joint, rehabilitation, distal biceps brachii tendon rupture, minimally invasive surgery, biceps tenodesis, cortical button fixation, tendon reinsertion

INTRODUCTION

Ruptures of the distal biceps brachii tendon (DBBT) are relatively infrequent and occur, on average, in 1.2 cases per 100 000 patients per year, which amounts to approximately 3 % of all biceps tendon injuries [1, 2].

The ruptures in the vast majority of cases occur in the dominant limb in males in their fourth to sixth decades of life or during an excessive eccentric contraction of the biceps brachii with the flexed and supinated forearm [3]. Compared to males, distal biceps tendon ruptures in females are extremely rare. According to Christopher R. Jockel, 15 female patients aged from 48 to 79 years were treated surgically for distal biceps tendon tears at a single institution over the period of 10 years [4].

Patients with avulsion of DBBT normally report acute pain, immediate swelling, significant weakness with flexion and supination, and palpable percutaneous defect at the elbow crease [3].

It is generally recommended that nonoperative treatment including orthopaedic regime, immobilization and nonsteroidal anti-inflammatory drugs (NSAIDs) be implemented for patients with partial injury to DBBT, low functional demands or those that have significant risk factors for peri-operative complications. The above management was associated with a 2.5-fold increased duration of treatment compared to that of invasive techniques [5] and would not be discussed in the article.

Significant variations exist within the literature regarding the distal biceps footprint, less invasive Boyd-Anderson approach is often results in heterotopic ossification and the original technique developed by Dobbie leads to a high incidence of neurologic injury [6, 7]. Most authors now recommend anatomic reattachment to the radial tuberosity [8, 9].

Objective The purpose of the study was to present the clinical experience and compare methods of fixation of the distal biceps brachii tendon in terms of their advantages and postoperative complications, optimization of rehabilitation protocol based on short- and long-term outcomes.

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MATERIAL AND METHODS

The retrospective study included 20 patients with DBBT requiring operative repair between 2014 and 2017 at the Novosibirsk Tsivyan Scientific Research Institute of Traumatology and Orthopaedics (NTSRITO). The study was reviewed and approved by institutional review board and was conducted in compliance with Good Clinical Practice and the principles of the Declaration of Helsinki. Written informed consent was obtained from all the patients.

Nonoperative treatment including immobilization either with a sling or hinged orthosis, orthopaedic regime and NSAIDs was primarily indicated for the majority of the patient that sought medical care at the inpatient department of the institute. Corticosteroid injections, physiotherapy and exercise therapy were excluded from the treatment [10]. Surgical treatment was employed with failed conservative management or a need of aggressive orthopaedic rehabilitation in a group of sportsmen. Stable pain, swelling and disturbed flexion/supination of the arm were indications to invasive management [11].

Surgical management

Surgical procedure was performed in an open manner in all the participants. The clinical observations were subdivided into subgroups by:

– surgical approach: Dobbie anterior approach (n = 4; 20 %) and Boyd-Anderson less invasive technique (n = 16; 80 %) (**Fig. 1**) [12];

– type of implant and technology of reinsertion: cortical button + interference screw developed by Bain GI (**Fig. 2**) (n = 11; 55.0 %), cortical button (n = 4; 20.0 %), anchor fixation (n = 3; 15.0 %), transosseous suture (n = 2; 10.0 %);

– an injury resulting from accidents at home (n = 12; 60.0 %), industrial accidents (n = 2; 10.0 %), sports activities (n = 5; 25.0 %) and road traffic accidents (n = 1; 5 %). All 20 patients were males (100.00 %), no females. The mean patients' age was 44.05 years;

– an interval between an injury to the elbow joint and visit to a doctor: within 24 hours (n = 1 (acute trauma); 5.0 %), 10 to 12 months (n = 18; 90.0 %; M – 92.26 days) with nonoperative treatment provided, after 12 months (n = 1 (chronic case); 5.0 %) with surgical management provided;

– localisation: injury to dominating hand (n = 18; 90.0 %), contralateral joint (n = 2; 10.0 %), right upper extremity (n = 17; 85.0 %), left limb (n = 3; 15.0 %).

Fig. 1 Intraoperative photographs taken at stages of surgical management using less invasive Boyd-Anderson approach and radiological check-up with modified technique of cortical button fixation of DBBT developed by Bain

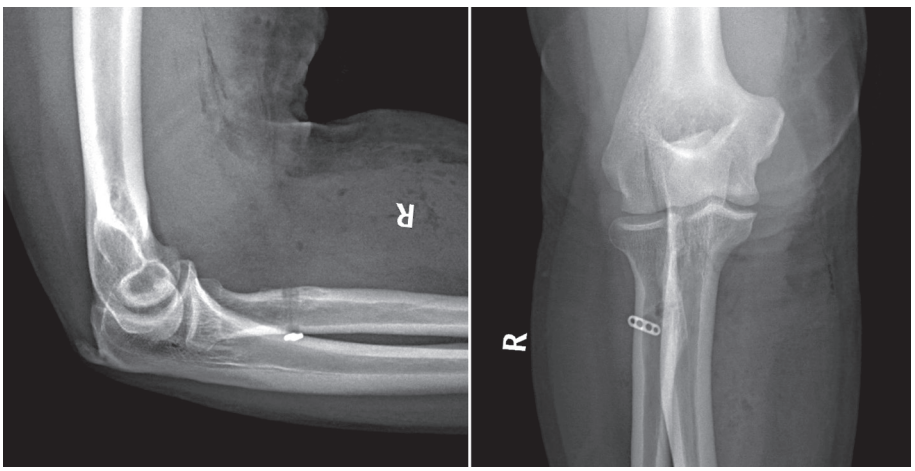

Fig. 2 Postoperative AP and lateral views of the elbow joint in a 48-year-old patient E. treated with cortical button fixation of DBBT developed by Bain

Diagnostic techniques used included:

– clinical examination (complaints and medical history, physical assessment; "the moving valgus stress test" developed by O'Driscoll, the biceps squeeze test developed by Ruland) [13];

– imaging (comparative radiography (AP and lateral views) of both elbow joints, ultrasound of soft tissues at the elbow joint, MRI). Comparative radiographs (AP and lateral views) of injured and contralateral joints showed greater diastasis between radius and ulna at the biceps tuberosity (n = 14; 70.0 %) and signs of heterotopic ossification (n = 4; 20.0 %) in cases of delayed injury to soft tissues at this area; marginal cortical avulsion fracture of the tubercle in high-energy trauma (n = 2; 10.0 %). Elbow magnetic resonance imaging at 1.5 T (n = 10; 50.0 %) demonstrated periosteal reaction of the radial tubercle and differentiated tissue degeneration from avulsion injury to DBBT.

RESULTS AND DISCUSSION

Postoperative period was uneventful. The mean inpatient period was 3 days/bed. Follow-up at the NTSRITO was available for 15 patients (75.0 %) from 1 to 3 years and 5 patients (25.0 %) could not visit the hospital but they answered questionnaires either by phone or by e-mail. No cases of rerupture were observed.

Short-term follow-ups were evaluated from 6 months to 1 year by the criterion:

1) satisfactory outcome (n = 19; 95 %) with clinical signs of absent pain, normal range of motion in the operated joint recovered, return to everyday life and work;

2) poor outcome (n = 1; 5 %) with one of the clinical signs noted: persisted pain, residual contracture in the operated joint. Early neuropathy of the radial nerve seen at physical examination and with ENMG was observed with Dobbie approach and anchor fixation of DBBT [6, 14].

Disabilities of the Arm, Shoulder, and Hand (DASH) and Visual Analogue Scale (VAS) were employed as outcome measured. No case of superficial or deep local inflammation of the surgical wound was observed. The majority of patients reported discomfort postoperatively measuring 4 on VAS (Visual Analogue Scale, Huskisson E.C., 1974) within the first three weeks that decreased to 1 starting from week 6.

Disability period was 33.5 ± 0.5 days in patients of intellectual labour and 45.5 ± 0.71 days in patients of manual labour, physically active persons and sportsmen.

Long-term outcomes were evaluated 3 years later. Consistency of reinsertion and degenerative component of DBBT was evaluated at follow-up conducted at the NTSRITO inpatient department using American Shoulder and Elbow Surgeons (ASES) and Disabilities of the Arm, Shoulder, and Hand (DASH) Score as well as Visual Analogue Scale (VAS), US and MRI examinations. Questionnaires were filled out by the patients during their follow-up visit. DASH score measured upper extremity disability from 0 as good functionality to 10 as extreme disability. DASH scores were 1.3 to 2.8 points. DASH disability/symptom score was measured using the formula, DASH disability/symptom score = [(mean DASH score amount) – 1] × 20/n, where n, a number of respondents and was equal to 26.1 out of 100 that corresponded to a good result.

Statistical analysis

The Spearman Rank nonparametric test was used to analyze statistical correlation between quantitative variables. $P < 0.05$ was considered statistically significant. Correlation between complete recovery and patient's age was statistically significant with $p > 0.05$. The relation between complete recovery and an interval between injury and operative intervention was not statistically significant ($p > 0.05$).

Non-parametric Mann-Whitney test was used to evaluate the differences between timings of full recovery with different types of injury, technique and approach used. Differences between periods of rehabilitation with sports related injury, and home and industrial accidents were found statistically significant ($p < 0.05$). Differences between home and industrial accidents were insignificant ($p > 0.05$).

Sports related injury was evaluated separately due to greater influence of mechanism of injury on intervention technique and the approach employed.

Statistically significant differences between rehabilitation length following cortical button and screw fixation, and standalone cortical button, anchor or transosseous suture fixation could be assessed only with injuries resulting from accidents at home. Since anchor fixation and transosseous suture were not used for sports related injury repair a combination of cortical button and interference screw fixation was employed in 4 out of 5 cases (80 %) and standalone cortical button fixation performed for one patient (20 %).

Results of operative repair with cortical button fixation ($n = 8$) were significant ($p < 0.05$) as compared to other techniques ($n = 5$). A 2-fold improved outcomes of cortical button fixation compared to alternative repair were statistically significant ($p < 0.05$). Our findings were in line with similar data reported in the literature [15, 16, 17, 18].

Outcomes of different approaches could be evaluated in trauma cases caused by accidents at home due to the size of the sample ($n = 13$). A 2.3-fold improved outcome of Boyd-Anderson approach was statistically significant as compared to that achieved with Dobbie technology ($p < 0.05$).

Postoperative rehabilitation

There is a wide range of rehabilitation protocols aimed to restore range of motion in the elbow joint, muscle balance and eliminate contracture in a faster manner with aggressiveness of rehabilitation techniques growing annually [19, 20]. Double fixation method of cortical button and interference screw used as the "gold standard" allowed for accelerated rehabilitation [21, 22]. Our protocol involved postoperative fixation of the arm with a sling from 3 to 5 days, upper limb compression sleeve class I, passive elbow rotation and flexion during the first week. Range of motion in the joint: 2nd week 2, 45–100 degrees, 4th week, 30–115 degrees, 6th week, 15–130 degrees of flexion. Strengthening exercises were started with 1-kg weights from the 2nd postoperative week adding 1 kg every week within one month if pain allowed. Weights increased to 3 kg after seven weeks. No active motion and overextension permitted within 8 to 12 weeks. Manual kinesiotherapy and hardware-based mechanotherapy are encouraged consecutively at the time with potentially increasing amplitudes in passive mode. Electric stimulation of the forearm flexors and extensors, biceps brachii muscle, pain controlled strengthening exercises were recommended after 6 weeks of passive exercises. Patients who underwent cortical button and combined cortical button and screw fixation showed good clinical results of rehabilitation after 6 weeks ($n = 13$; 65 %) and after 8 weeks ($n = 2$; 10 %). Patients whose injury was repaired with anchor implants and transosseous sutures (15 %) required 12 to 16 weeks, on average. Rehabilitation lasted for 24 to 26 weeks in the group of sportsmen.

CONCLUSION

The study reviews aspects of treatment, surgical approaches and implantation, rehabilitation protocol of patients with distal biceps brachii tendon ruptures. Working-age patients with injury to the DBBT older than 6 weeks and persisted pain at the elbow crease were followed up for three years after failed nonoperative repair. The findings showed advantages of combined cortical button and interference biodegradable screw fixation of the DBBT. A 2-fold improved outcome of the fixation was observed in comparison to anchor and transosseous repair [23]. A 2.3-fold improved outcome of Boyd-Anderson approach was statistically significant as compared to that achieved with Dobbie technology ($p < 0.05$). Correlation between complete recovery and patient's age as well as relation between complete recovery and an interval between the injury and operative intervention was less significant. The 'gold standard' surgical technique allowed for aggressive rehabilitation of 20 sports-oriented patients of working age with the majority being capable to recover after injury and surgery within the time that cannot be ensured by other methods of treatment.

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