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The Nearest Clinical and Structural Results of Arthroscopic Reconstruction of the Upper Capsule in Patients with Cuff Tear Arthropathy after a Massive Rotator Cuff Tear

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Abstract

The purpose of the study was to evaluate the nearest clinical, functional and structural (according to MRI) results of arthroscopic reconstruction of the shoulder upper capsule using an acellular dermal collagen matrix and auto-tissue of the ileotibial band in the patients with shoulder arthropathy after a massive rotator cuff tear. ***Material and Methods.*** The study included 30 patients with stage I–IV shoulder arthropathy according to K. Hamada classification. All of them were undergone the arthroscopic reconstruction of the upper part of the shoulder capsule in 2017–2018. The orthopedic procedures were performed by the same surgical team using an acellular dermal collagen matrix as a biological material (group 1) and auto-tissue of the iliotibial band (group 2). ***Results.*** The proportion of the patients with good — 8 (26.7%), satisfactory — 14 (46.6%) and poor — 8 (26.7%) surgical outcomes was determined according to the ASES functional assessment scales. Transplant ruptures were recorded in one (3.3%) patient in the group with an acellular dermal collagen matrix and in two (6.6%) patients in the group with the iliotibial autograft. ***Conclusion.*** Arthroscopic reconstruction of the upper part of the shoulder capsule is a promising method for the surgical treatment of physically active working age patients with shoulder arthropathy after massive rotator cuff tear. The main goals are restoration of the shoulder vertical stability, centered position of the humeral head towards the glenoid, and improvement of the shoulder biomechanics as a whole.

Keywords: massive rotator cuff tear, shoulder arthroplasty, arthroscopic reconstruction, upper shoulder capsule, shoulder arthropathy.

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Introduction

Surgical treatment of the massive irreparable posterosuperior ruptures of rotator cuff remains a disputable issue [1, 2, 3, 4, 5, 6]. Low efficiency of arthroscopic tendon-bone suture anchor repair for such injuries is related to tendon retraction and high (over 50%) rate of fatty degeneration of muscle in the shoulder rotator cuff that define the notion of "irreparable tear" [5, 6, 7, 8].

Anatomical studies clearly demonstrated the features of texture and function of such structures like rotator interval and superior capsule of the shoulder joint confirming their major importance for ensuring alignment of humeral head and glenoid as the key factor for maintenance of normal biomechanics [9, 10].

Japanese orthopaedic surgeon Mihata in 2012 [11] presented the biomechanical rationale and first description of surgical technique for arthroscopic reconstruction of the superior capsule of shoulder joint. The key difference of described procedure from bridging "patch grafts" used earlier was that the proximal part of graft is fixed to the acromion and not to the border of retracted tendon of rotator cuff [12, 13]. The major idea of arthroscopic reconstruction of the superior capsule is to restore the alignment of biomechanical couple "humeral head — glenoid" with simultaneous reconstruction of pivot point ensuring humeral head rotation and favorable conditions for functional activity of extrinsic scapula muscles (first of all deltoid muscle) [14].

Currently, the world continues to accumulate clinical experience and improve surgical techniques of arthroscopic reconstruction for the superior capsule of the shoulder joint, as well as the further examination of clinical, functional and structural outcomes of such procedures [15, 16, 17, 18, 19]. Despite the fact that Mihata as the chief author of this technique actively promotes autograft from iliotibial band fascia (ITB autograft) as the biological material for transplantation, the material of choice for the wide orthopaedic practice in the United States and many European countries is the acellular dermal collagen matrix (ADCM) [19, 20]. Such popularity and wide clinical application of ADCM as graft material for superior capsule is quite reasonable. First, the parameters of mechanical tensile strength, elasticity, stretching demonstrate the values superior to ITB autograft. Second, there are no issues related to "donor site" which significantly improves operative time and invasiveness of procedure [21]. In spite of growing popularity and more often application of such procedure in the current practice, the surgeons quite often wonder about its clinical efficiency and biological survival of the graft: is this "dead" tissue capable of remodeling and adaptation or it's destined to lyse and tear? [16, 22]. In view of the above, it seems relevant to perform the analysis of clinical examination and MRI data during dynamic postoperative follow up of the patients.

The purpose of the study — to evaluate short term clinical, functional and structural (by MRI) outcomes of arthroscopic reconstruction of the superior capsule of the shoulder joint using acellular dermal collagen matrix (ADCM) and ITB autograft in patients with shoulder arthropathy along with massive rotator cuff tear.

Material and Methods

30 patients with shoulder joint arthropathy of grade I-IV by Hamada accompanied by massive rotator cuff tear were included into the study. In 2017 and 2018 the same surgical team performed arthroscopic reconstruction of the superior capsule in these patients using ADCM (15 patients — group 1) and ITB autograft (15 patients — group 2). Age of patients ranged from 40 to 79 years with mean of 62.8±11.2 years. There were 18 male and 12 female patients (table 1). Right joint was operated in 18 cases and left joint — in 12 cases. 22 patients (73.3%) underwent surgery on the dominant arm. 8 patients (26.7%) al-

ready had in their medical history one up to three failed attempts to repair posteriosuperior portion of rotators using various options of arthroscopic tendon-bone suture anchors. During preoperative planning moderate pseudoparalysis of the upper extremity was reported for 22 out of 30 patients. Humeral head dislocations prior to surgery were noted in medical histories of three out of 30 patients.

Study *inclusion criteria* were as follows: signs of massive rotator cuff tear (two or three tendons involved), shoulder arthropathy signs of grades I-IV by Hamada classification, intact or potentially repairable injury of subscapularis tendon and fully intact deltoid muscle.

Exclusion criteria were as follows: x-rays signs of severe alterations of bone-cartilage structure of the shoulder joint (cystic degeneration, avascular necrosis of the humeral head and glenoid), clinical and electroneuromyographic (EMG) signs of contractility and functional disorders of deltoid muscle as well as severe neuropathic pain during preoperative examination.

All patients were examined in pre- and postoperative (3, 6, 12 months) period assessing pain by VAS and performing tests with weights; evaluation of range of motion, muscular force and functional disorders evaluation by ASES survey; patients' satisfaction by VAS scale; as well as control X-ray and MRI imaging.

Follow up period was from 6 months to 2 years after surgery. Mean follow up was 14.1±6.3 months.

Statistical analysis

Statistical data processing was performed with Statistica 10 (StatSoft, USA) software. Descriptive statistics indicating mean values and standard deviation was used to reflect general characteristics of base parameters. For variables with normal distribution groups were compared using Student's t-test. The condition of variances equality was checked by the Levene's criterion. To determine statistical significance of variances between the groups the authors used Mann-Whitney U-test for quantitative (other than normal distribution) and ordinal variables, for qualitative — χ^2 criteria and Fischer exact test. Wilcoxon test was used to compare quantitative and ordinal variables in dependent samples. The critical value was considered $p<0.05$.

Surgical technique

Patient was placed in a lateral position with a removable wrist axial traction (weight of 2 kg). Patients were fixed lying on intact side with vacuum mattress. Abduction angle for the operated arm ranged from 20 to 30°. All procedures were performed arthroscopically through five standard portals (posterior, anterior, posterolateral, anterolateral and Neviaser portals) as well as two supplementary miniportals for introduction of the anchors.

Table 1

Key parameters of the patients

Parameter	Group 1 (n = 15)	Group 2 (n = 15)	*p*
Gender: m/f	11 (73%) / 4 (27%)	7 (47%) / 8 (53%)	0.136*
Age, years	62.6±12.2	63.1±10.2	0.803**
Follow up period, months	16.0±5.8	12.3±6.3	0.089***
Treatment option: conservative / surgery	10 (67%) / 5 (33%)	7 (47%) / 8 (53%)	0.269*

* — χ^2 criteria; ** — Student's test; *** — Mann Whitney U-test.

The surgery began with V-shape tenotomy or tenodesis of the long head of biceps, resection of the tissue in the medial and central portion of rotator interval ensuring preservation of coracohumeral ligament. In case the subscapularis tendon was injured the authors reconstructed it with SpeedFix technique.

Then the posterosuperior portion of rotators was mobilized using ablator and shaver to split fibrous fusions between tendon border and tissues of subdeltoid fascia, of acromion, acromioclavicular joint, coracoacromial ligament.

After complete removal of soft tissues on the superior surface of acromion and base of coracoid process through anterior and Neviaser portals, two anchor SutureTak fixators 3 mm in diameter were inserted into the scapula for fixation of the medial part of the graft of the superior portion of shoulder capsule.

All tendon remnants were removed from the greater tuberosity of the humerus, then through the two supplementary mini-portals two knotless SwiveLock anchors 4.75 mm in diameter loaded with one suture and one band each were inserted at an angle of 45° by the tear edge at the level of articular cartilage of the humeral head.

After insertion of four anchors arthroscopic liner was used to measure length and width of rotator defect adding 10mm to its length (in medial and lateral views) and 5 mm to its width (in anterior and posterior views) to obtain true dimensions of the planned graft. Prepared ADCM grafts (group 1) with dimensions of 5×5 cm or 6×8 cm or an ITB autografts (group 2) of corresponding dimensions were used for transplantation (Fig. 1). To obtain optimal thickness (no less than 6 mm) during graft preparation the dermal matrix it was folded two or three times and ITB graft — folded three of four times. Desire to increase thickness of the graft was aimed not only to ensure anatomical reconstruction of the superior capsule itself but to obtain a "spacer effect" able to compensate other layers of rotator interval — first of all the fibers of coracohumeral ligament located in front of supraspinatus tendon.

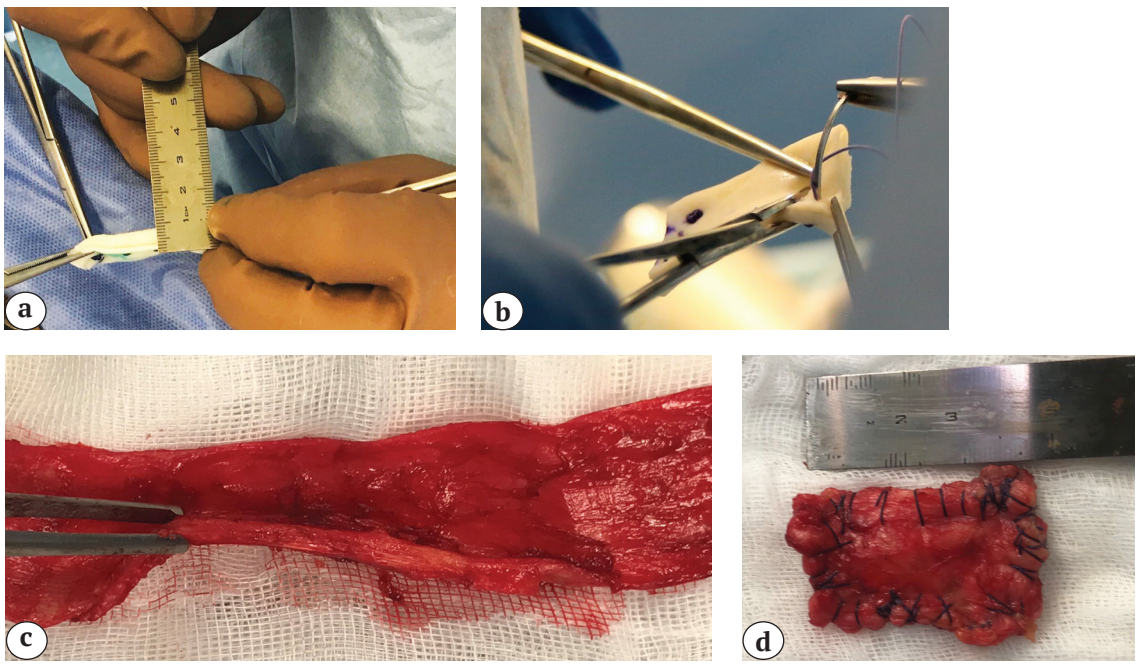

Fig 1. Stages of transplant preparation:
a, b — preparation of an acellular dermal collagen matrix (group 1);
c, d — preparation of auto-tissue of the iliotibial bands (group 2)

Grafts were stitched extraarticular and then inserted into the joint through a rubber PassPort cannula 12 mm in diameter placed in the anterolateral portal. Inside the joint grafts were adapted to bone and fixed by anchors to acromion and humeral head.

Medial portion of the graft was fixed by a single row knot sutures to the superior part of acromion using SutureTak anchors, lateral portion — to the greater tuberosity of humerus by SpeedBridge technique, posterior and anterior portions — by knot sutures to remnants of supraspinatus and infraspinatus tendons (Fig. 2).

The authors observed base pathology of the shoulder joint featuring involvement of rotator cuff tendons into the tear. In all cases supraspinatus tendon was involved — 15 (100%) / 15 (100%) for groups 1 and 2, respectively. Infraspinatus tendon was involved in 13 (86.7%) / 14 (93.3%) cases, subscapularis tendon — in 7 (46.7%) / 8 (53.3%) cases, respectively, no injury of teres minor was observed. Transverse tears in both groups ranged from 35 to 40 mm, shoulder arthropathy index (by Hamada classification) varied from 1 to 3 in group 1 and from 1 to 4 in group 2. Graft width ranged from 4 to 5 mm in group 1 and from 5 to 7 mm in group 2.

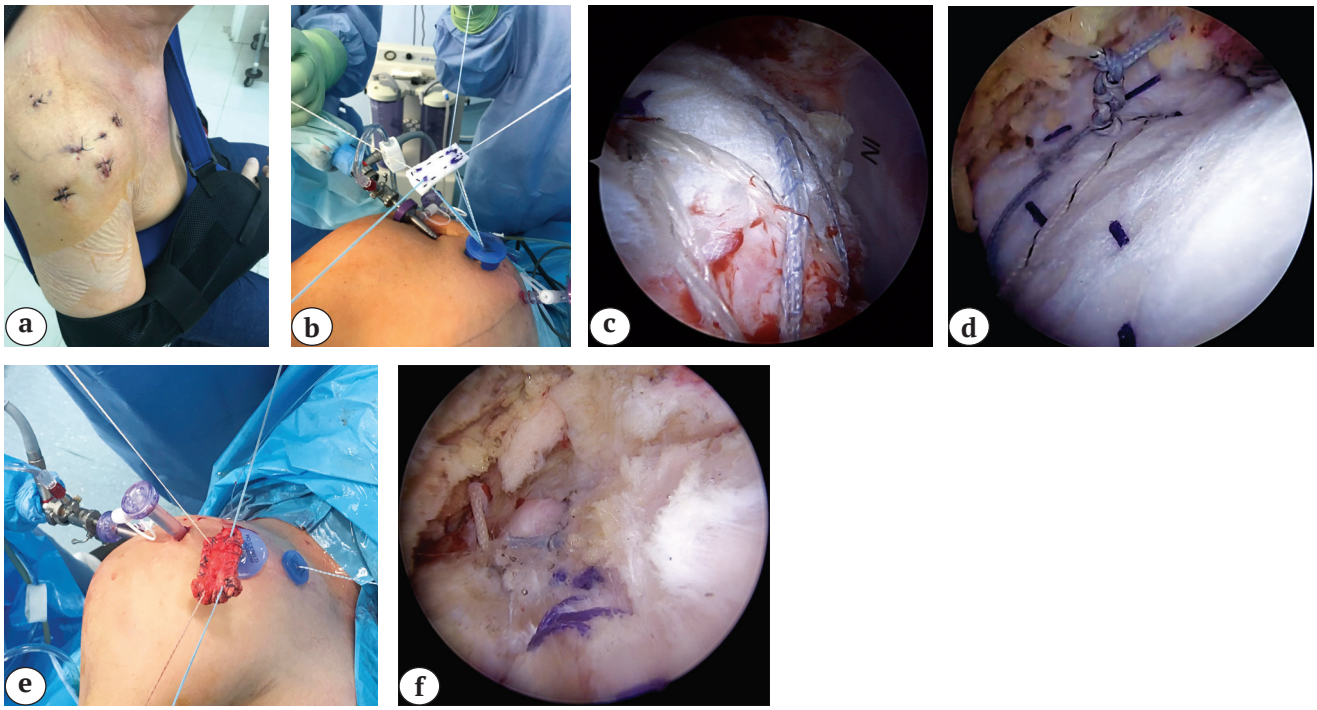

Fig. 2. Stages of the arthroscopic reconstruction of the upper shoulder capsule:
a — arthroscopic portals;
b — external suturing of an acellular dermal collagen matrix graft with ligatures from anchor fixators before insertion into the joint;
c — double-row bridge-shaped anchor fixation of an acellular dermal collagen matrix transplant to the greater tuberosity, SpeedBridge technique;
d — single-row anchor fixation of an acellular dermal collagen matrix transplant;
e — external suturing of the iliotibial band autograft with ligatures from anchor fixators before insertion into the joint;
f — view of the implanted iliotibial band autograft

In all patients the following procedures accompanied the arthroscopic reconstruction of the superior shoulder capsule: grafting of acromion, grafting of coracoid process, subacromial and subclavicular bursectomy, anterior capsulotomy, tenodesis of the long head of humeral biceps.

Results

Clinical and functional outcomes

Basing on the functional ASES scores the authors reported the following outcomes of surgery: good — 8 (26.7%), satisfactory — 14 (46.6%) and poor — 8 (26.7%).

At the moment of examination of patients with massive rotator cuff tears after arthroscopic reconstruction of superior portion of shoulder capsule pain syndrome was fully absent in 15 (50%) patients, pain was periodically disturbing during physical load in 9 (30%) patients, and persisted pain (both in rest and at night) — in 6 (20%) patients. It should be noted that neuropathic pain origin was reported in all patients with persisting pain. Patients' expectations for pain reduction or relief by VAS were met in 22 (73.3%) patients at the average of 6.0±1.5 scores.

Mean ASES scores prior to surgery and at the moment of examination were 34.6±8.7 and 64.6±17.8, respectively. Positive dynamics was reported for all examined patients (highly significant differences; p<0,001) as compared to average preoperative findings.

Elimination of pseudoparalysis signs for the upper extremity was achieved in 16 out of 22 patients (53.3%) who demonstrated those signs prior to surgery, however 3 (10%) patients still had the signs of deep pseudoparalysis at the moment of examination which was confirmed by positive drop arm test, ERLS-test and, consequently, by difficulties in everyday life and work. The authors reported combined contraction in 10 (33.3%) patients at the moment of examination. Mean age of patients with pseudoparalysis of the upper extremity and contraction in postoperative period was 67.2±2.3 years. As a rule, reduced tone of deltoid muscle was also observed in such patients at the examination.

Muscular force of the operated arm was affected to a certain extent in all patients as anticipated. At examination the authors observed abduction and elevation with 0.5–1,5 kg weight in 22 (73.3%) patients, 2–3 kg — in 5 (16.7%) patients and with bigger weights — in 3 (10%) patients. 20 (66.6%) out of 30 patients prior to surgery had work associated with physical loads, 15 (50%) of those patients could get back to previous level of physical activity.

Eight (26.7%) patients constituted the group with good outcomes. Mean age of such patients was 55.6±11.4 years. Patients did not have any complaints for pain and discomfort at surgery site. ROM in the operated joint was reported as follows: abduction and flexion (elevation) ranged from 160 to 180°, active and passive external rotation of adducted shoulder amounted to 45° enabling patients to actively hold shoulder joint in the position of maximum external rotation. All patients were able to do hard physical work and 6 (75%) patients continued amateur sports activity. Mean functional ASES score for the operated joint in such patients was 85.6±7.5.

Satisfactory outcomes were reported for 14 (46.6%) patients. Patients of this group complained of reduced ROM in the operated joint — active elevation and abduction ranged 90–160°, external rotation — up to 45°. In 6 (40%) patients the range of active shoulder elevation ranged 90–100° which confirmed moderate pseudoparalysis of the upper extremity. Active abduction was possible with weights of 1.5–2.0 kg. Patients of this group reported reduced daily life physical activities: reduced muscular force, inability to do hard physical work, inability to precisely position the operated arm in the space when performing complex movements. Mean functional ASES score in these patients was 65.1±5.4.

Poor outcomes were reported in 8 (26.7) patients. Despite the absence of persisting pain in such patients, they demonstrated reduced range of active abduction and arm elevation from 0 to 90°. At the same time, the authors reported positive ERLS-test. Above findings allowed to confirm moderate and deep arm pseuroparalysis in those patients. Active abduction was possible with weights less than 1 kg.

One case with poor outcome was related to development of deep surgical site infection in the early postoperative period (6 weeks after arthroscopic reconstruction) and infectious shoulder arthritis requiring removal of graft and anchors (microbiological examination of biopsy material identified MRSE as infection agent) (Fig.3). One female patient with grade IV shoulder arthropathy (by Hamada classification) featured rupture along the graft during rehabilitation 3 months after the arthroscopic reconstruction with ADCM (Fig.4).

Data on the number and type of complications, treatment options after arthroscopic reconstruction of superior shoulder capsule in groups of patients with ADCM and ITB autograft is given in Table 2.

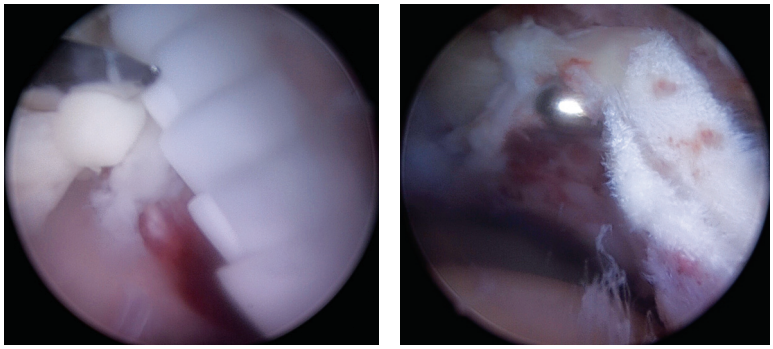

Fig. 3. Arthroscopic picture of implant migration from glenoid and the graft lysis against a background of the surgical site deep infection

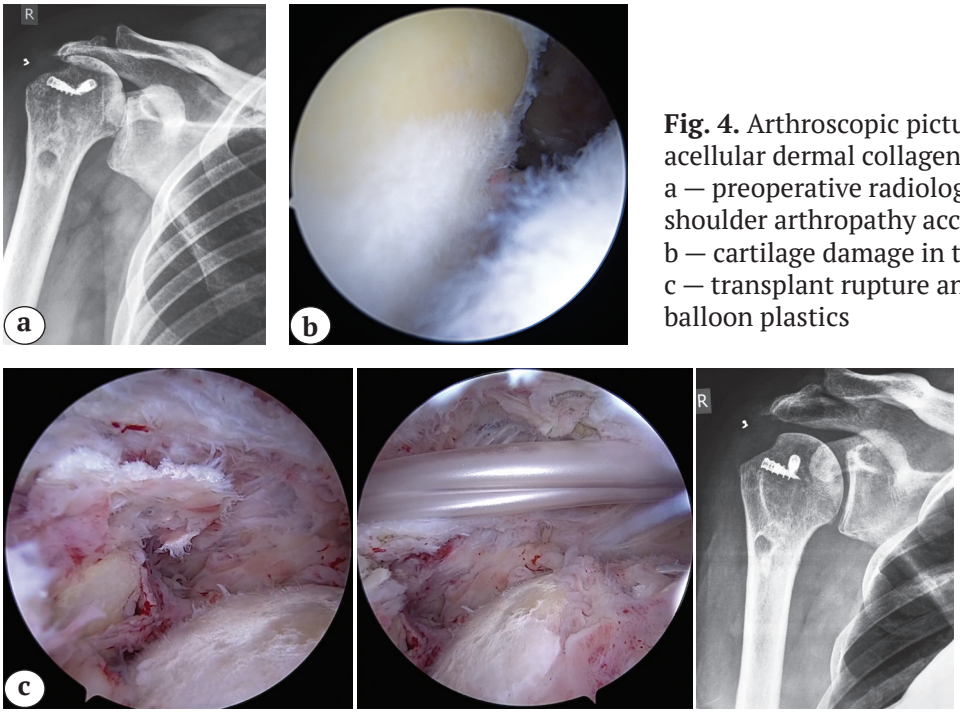

Fig. 4. Arthroscopic picture of the rupture of an acellular dermal collagen matrix graft:
a — preoperative radiological signs of stage IV shoulder arthropathy according to K. Hamada;
b — cartilage damage in the upper part of glenoid;
c — transplant rupture and X-ray after temporary balloon plastics

Table 2

Complications and treatment options after arthroscopic reconstruction of the superior shoulder capsule

Graft source	Number of complications	Type of complications	Revisions
Acellular dermal collagen matrix (ADCM)	2	One rupture, one infection	One balloon grafting, one removal of graft, antibiotic therapy
Autograft from iliotibial band (ITB autograft)	2	Two ruptures	Two balloon grafting
Total	4	Three ruptures, one infection	Three balloon grafting, one graft removal, antibiotic therapy

Data given in the table 3 indicates that along the comparable parameters of patients' satisfaction with outcomes of arthroscopic reconstruction the mean values of ROM in the operated joint and mean ASES scores in the group of patients with ADCM were superior to the findings in the groups of patients with ITB autografts. Average follow up was 14.1±6.3 months.

Table 3

Comparative characteristics of the groups

Parameters		Group 1 (n = 15)	Group 2 (n = 15)	p
ASES functional assessment, scores	Preop.	36.7±10.7	32.7±5.9	0.213*
	Postop.	69.8±21.0**	59.5±12.6**	0.051*
	p	0.001**	0.001**	—
Pain by VAS, scores	Preop.	5.9±1.6	5.6±1.3	0.663*
	Postop.	1.9±1.6**	2.2±1.3**	0.384*
	p	0.001**	0.001**	–
Flexion, °	Preop.	92.1±9.4	84.8±7.3	0.231*
	Postop.	162.3±13.2**	137.8±10.8**	0.156*
	p	0.001**	0.001**	–
Acromiohumeral interval, mm	Preop.	1.0±0.7	1.2±1.0	0.754*
	Postop.	3.62±1.35**	3.9±2.44**	0.803*
	p	0.001**	0.001**	–

* — Mann Whitney U-test; ** — Wilcoxon test.

Structural outcomes of arthroscopic reconstruction of the superior shoulder capsule (MRI findings)

Postoperative MRI examination of the patients allowed to identify individuals with full remodeling and retention of the graft — 6 (20%) cases, with signs of partial and full rupture and lysis of the graft — 20 (66.7%) and 4 (13.3%) cases, respectively (Fig. 5).

Obtained data demonstrated the majority of good and satisfactory outcomes in patients with full or partial retention of the graft, which occurred according to MRI in the period from 3 to 12 months after surgery during dynamic follow up (Table 4).

Of particular interest is the issue of dynamic evaluation of alterations in the tissue structure of ADCM basing on MRI findings. Already in 3 months after arthroscopic reconstruction the authors observed MR signs of significant structural tissue changes of the graft at the sites of graft contact with acromion, humeral head and especially in the area of suture fixation to remnants of infraspinatus muscle. T2 weighted imaging demonstrated changes from deep black to light gray coloration with clear cellular structure in cases with ADCM. In 6 and 12 months after surgery graft structure at sites of contact with bone and muscles changed again — during T2 weighted imaging gray color and cellular structure again turned black (Fig. 6).

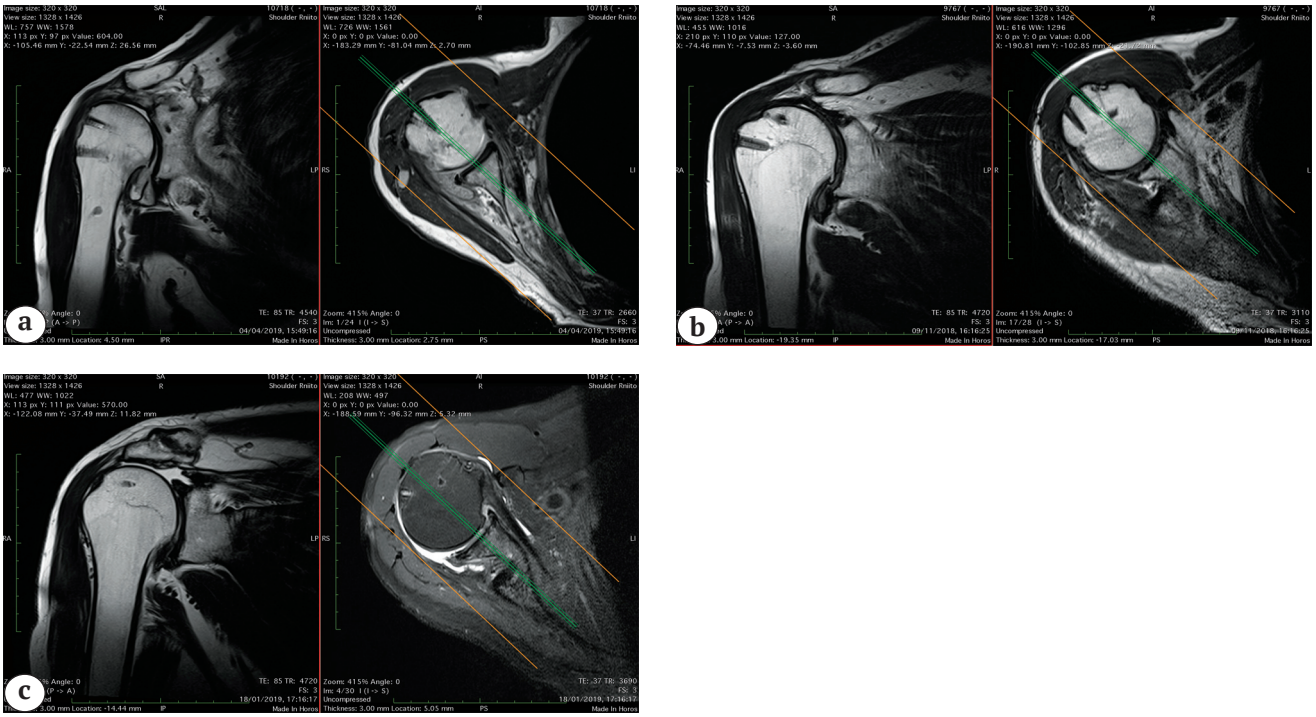

Fig. 5. Variants of the MRI picture of the transplant of the upper shoulder capsule:
a — complete restructuring and replantation (12 months after surgery);
b — variant of partial resorption of the unloaded part of the graft at the place of its fixation to the muscle and tendon parts of the infraspinatus muscle (9 months after surgery);
c — complete rupture throughout the graft and its lysis (4 months after arthroscopic reconstruction of the upper shoulder capsule)

Table 4

Distribution of patients according to clinical and functional outcomes - of the arthroscopic reconstruction of superior shoulder capsule

Clinical and functional outcome	Groups of patients depending on postoperative MRI findings illustrating degree of graft retention		
	Complete remodeling and retention of graft (*n* = 6)	Partial rupture of graft (*n* = 20)	Complete rupture and lysis of graft (n = 3) / graft removal due to DSSI * (*n* = 1)
Good	4	4	0
Satisfactory	2	12	0
Poor	0	4	4

* DSSI — deep surgical site infection.

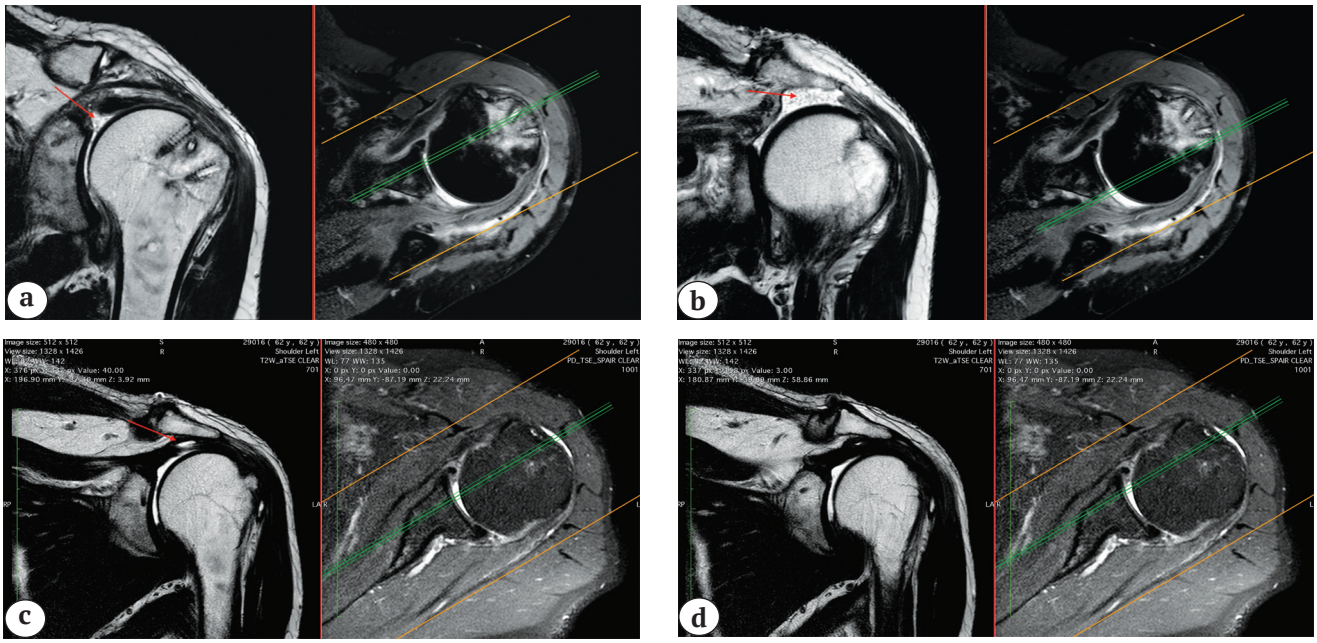

Fig. 6. Dynamics of tissue restructuring of an acellular dermal collagen matrix graft:
a — in places of its anchor fixation to the bone tissue of the glenoid and humeral head;
b — in places of suture fixation to the infraspinatus in 3 months after surgery
c — 6 months after surgery — graft structure cellular (loose);
d — 12 months after surgery — more dense graft structure (complete transplant remodeling)
The graft marked with arrow

Based on MRI acromiohumeral interval reduced in time after surgery in group 1 but such tendency was not observed for group 2. This confirms higher stretching and elongation of graft from ADCM as compared to ITB autograft. So, acromiohumeral interval in groups of patients with ADCM and ITB autograft varied from 0.1 to 2.5 mm and from 0.2 to 3.1 mm in preoperative period, from 1.9 to 6.4 and from 3.9 to 8.9 mm — one year postoperatively, and from 1.7 to 5.9 and from 3.7 to 8.7 mm, respectively, — 2 years postoperatively.

Discussion

By now many surgical treatment options addressing massive rotator cuff tears were developed and actively used in the world practice, however, we are still lacking a rational algorithm of their application [23]. Thus, operative techniques for partial arthroscopic repair of tendons in rotator cuff give the opportunity to achieve ASES clinical and functional outcomes of 77.0–85.7 scores after isolated application and of 72.3–88.7 scores after using a combination with bridge patch biografts [24, 25, 26, 27, 28]. However, both options mentioned above have a high frequency rate of recurrent tears in rotator cuff tendons and revisions (41.6–52.0% and 12–24%, respectively) according to clinical studies [8, 24, 26, 27, 28].

Surgical arthroscopic transfer of latissimus dorsi tendon also allows to restore ROM in the shoulder joint and improve clinical and functional status of patients achieving ASES scores of 61–70. However, this method is technically challenging, it radically changes normal shoulder biomechanics and, according to literature, has a high risk of chronic pain syndrome with progressing shoulder osteoarthritis in 29–50% of patients [29, 30].

Finally, in patients with massive rotator cuff tears and accompanying shoulder arthropathy of grades IV-V by K. Hamada classification the reverse shoulder joint arthroplasty is most preferred treatment method [31]. It's known that reverse shoulder joint arthroplasty efficiently resolves the issue of pain syndrome and yields good ASES scores of 65.8–77.0 but limits shoulder flexion up to 117–121° which can be the cause of constrained physical activity and dissatisfaction with treatment outcomes in patients of active working age [32, 33, 34]. Besides, reverse shoulder arthroplasty features variable data in respect of complications (from 13.9% to 39.0%) but a very limited list of revisions [31, 32].

According to literature arthroscopic reconstruction of superior shoulder capsule allows to gain ASES scores of 67.5–82.0 which matches the results of the present study: average score 69.8±21.0 and 59.5±12.6 after use of ADCM and ITB autograft, respectively. Such scores after arthroscopic reconstruction are quite comparable to similar efficiency results of abovementioned alternative methods and have certain advantages like higher flexion (147–160°) in the joint than after reverse shoulder arthroplasty (117–121°), and lower revision rate (11.7%) than after partial arthroscopic repair of rotator cuff (12–24%) [29, 30, 32, 33, 34]. Use of arthroscopic reconstruction of superior shoulder capsule in the present study allowed to gain shoulder flexion of 162.3±13.2° and required revisions only in 4 (13.3%) patients.

Surgical technique of arthroscopic reconstruction of superior shoulder capsule continues improvements by healthcare professionals aiming at better functional outcomes and reduced number of complications [35]. Preceding biomechanical research demonstrated that medial fixation of patch biografts to tendon and muscular remnants of rotator cuff suffering from fatty degeneration and atrophy with high probability results in failed clinical functional and MRI outcomes [11] in contrast to acromion fixation during arthroscopic reconstruction.

Mihata et al. proved the better shoulder joint stability due to restoration of tone and compression force of potentially intact sub-

scapularis muscle in their cadaveric research dedicated to circular restoration of superior shoulder capsule with graft fixation to acromion, humeral head and remnants of rotator cuff; Mihata et al. presented also the data on significant reduction of subacromial contact pressure on rotator cuff elements when using acromion grafting [13, 36]. Dynamics of MRI changes in the structure of ADCM in the present study were confirmed by recently published clinical case of authors from the USA who performed histological examination of removed humeral head together with fixed ADCM graft implanted 4 months ago. In their paper these authors presented evidence of active remodeling (re-cellurization and neovascularization) of ADCM at sites of its fixation to glenoid, humeral head and muscular and tendon tissues of rotator cuff [37].

The most controversial aspect of arthroscopic reconstruction of superior shoulder capsule is the use of alternative sources of biological tissues. Despite the fact that initially the arthroscopic reconstruction was suggested and developed for application of ITB fascia autograft, today surgeons in the USA widely use ADCM [19, 20]. The authors of the present study by now did not find in the literature clinical studies dedicated to arthroscopic reconstruction of superior shoulder capsule with high level of evidence and stratified by graft type.

T. Mihata et al. in their cadaveric study observed that in result of hardware biomechanical testing by uniform cyclic load elongation of ADCM amounted to 15% while ITB autograft preserved base length [11]. Besides, a series of studies by different authors demonstrate graft elongation and persisting anterosuperior humeral head dislocation after application of ADCM which is confirmed by reduced acromiohumeral interval in the studied patients [38, 39]. Preoperative parameters of acromiohumeral interval varied from 4.5 to 7.1 mm, those were improved up to 7,6–10,8 mm in short term postoperative period and then regressed to 6.7–9.7 mm during longer follow up [38, 39].

Lee et al. considered acromiohumeral interval as the key predictor of graft failure for arthroscopic reconstruction of superior shoulder capsule [38].

Taniguchi et al. found a statistically significant correlation between parameters of postoperative acromiohumeral interval after restoration of massive rotator cuff tear and clinical and functional outcomes [39].

The available literature did not provide any evaluation of changes in acromiohumeral interval prior to and after arthroscopic reconstruction of superior shoulder capsule using ITB fascia autograft. The present research demonstrated that acromiohumeral interval in patients after application of ITB autograft was approximately the same in one and in two years after surgery amounting to average of 7.3 mm and 6.9 mm, respectively. There is some research data demonstrating that rupture rate of ADCM graft was 15.2%, three times higher than for ITB autograft (5.0%), probably due to above mentioned elongation and anterosuperior migration of humeral bone [8, 23, 26]. In the present research the authors observed graft rupture in one (3,3%) patient in group with ADCM and two (6,6%) patients in group with ITB autograft.

Complications also varied depending on the graft source — ratio of graft failure rate was in favor of ITB autograft, while for other complications the situation was quite different: sutures failure — 23.5% for ITB autograft against 0% for ADCM; postoperative ruptures of infraspinatus tendon — 17,6% for ITB autograft against 3,0% for ADCM; postoperataive shoulder contraction — 11,8% for ITB autograft against 0% for ADCM [40]. Higher tensile strength of ITB fascia graft against ADCM probably contributes to the last mentioned complication. In particular, Mihata et al. demonstrated that circular capsular convergence of ITB autograft limits ROM and may result in shoulder contraction

while such effects were not observed after application of ADCM [40]. In the present study postoperative contractions were observed in 3 (10%) patients with ADCM and in 7 (23.3%) patients with ITB autograft. There is also an unproven hypothesis that circular continuity of superior capsule can be useful for ADCM reconstructions due to additional graft fixation and possibility to restrict mediolateral graft elongation [41].

Thus, current literature demonstrates that arthroscopic reconstruction of superior shoulder capsule is the promising surgical treatment for physically active patients of working age suffering shoulder arthropathy combined with massive rotator cuff tears. Technically the arthroscopic reconstruction is mostly resembling procedures with biopatch (scaffold) but the concepts and biomechanical rationales are fundamentally different. During replacement of the defect by biotissue of the graft the tendon tear is considered a significant injury to rotator cuff and the aim of procedure — to restore the anatomical continuity of contracted tendon fixed to surrounding tissues both along and at the attachment site in the proximal humerus. In contrast to that, arthroscopic reconstruction of superior shoulder capsule mainly aims at restoration of vertical shoulder joint stability, central positioning of the humeral head in relation to glenoid and improved shoulder biomechanics in general.

Publication ethics

Patients provided their voluntary informed consent to participation in the study.

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Authors' contributions

S.Y. Dokolin — study concept and design, evaluation and interpretation of results, preparing of paper.

V.I. Kuzmina — collection and processing of material, evaluation and interpretation of results, preparing of paper.

I.V. Marchenko — collection and processing of material, evaluation and interpretation of results, statistical processing of data.

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