SURGICAL TREATMENT OF MASSIVE ROTATOR CUFF TEARS (LITERATURE REVIEW)

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ABSTRACT

The prevalence of rotator cuff tears according to the literature ranges from 20 to 40 %, and this injury occurs more often in people over 60 years of age. Massive rotator cuff tears account for 10–40 % of all rotator cuff tears. Massive rotator cuff tears are considered to be tears with a diastasis of more than 5 cm or tears involving two or more tendons. With such injuries, the kinematics of the shoulder joint changes: proximal subluxation of the humeral head and arthropathy of the shoulder joint occur, which subsequently causes pseudoparalysis. The main clinical manifestations are pain and dysfunction of the shoulder joint. Patients may experience a loss of active range of motion in the shoulder joint while maintaining passive range of motion. There is currently no unified approach to the choosing the tactics for surgical treatment. The most common options include partial rotator cuff repair, subacromial balloon plasty, replacement of tendon defects with allografts and autografts, proximal shoulder joint capsule plasty, muscle-tendon transfers, and shoulder joint arthroplasty. However, according to the literature data, the frequency of re-ruptures after surgery ranges from 11 to 94 %. Despite the large number of methods for the treatment of massive rotator cuff tears, there are no clear algorithms for managing patients and choosing one or another surgical tactics. In addition, there is a high percentage of unsatisfactory outcomes of treatment. Taking all of these factors into account, the problem of improving the treatment of patients with massive rotator cuff tears remains relevant and timely.

Key words: *rotator cuff, surgical treatment, massive tears, supraspinatus tendon, shoulder joint*

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ХИРУРГИЧЕСКОЕ ЛЕЧЕНИЕ МАССИВНЫХ РАЗРЫВОВ ВРАЩАТЕЛЬНОЙ МАНЖЕТЫ ПЛЕЧА (ОБЗОР ЛИТЕРАТУРЫ)

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РЕЗЮМЕ

Встречаемость разрывов вращательной манжеты плеча, по данным литературы, составляет от 20 до 40 %, и чаще данное повреждение выявляется у лиц старше 60 лет. Доля массивных разрывов вращательной манжеты плеча составляет от 10 до 40 % от всех разрывов. Массивными разрывами вращательной манжеты плеча принято считать разрывы с диастазом более 5 см или разрывы двух и более сухожилий. При таких разрывах изменяется кинематика плечевого сустава, а именно происходит проксимальный подвывих головки плечевой кости, артропатия плечевого сустава, что в дальнейшем приводит к псевдопараличу. Основные клинические проявления – это болевой синдром и нарушение функции плечевого сустава. У пациентов может наблюдаться потеря активного диапазона движений в плечевом суставе при сохранении пассивных движений. Единый подход к выбору хирургического лечения пациентов на сегодняшний день отсутствует. Самыми распространёнными вариантами можно считать частичное восстановление вращательной манжеты плеча, субакромиальную баллонопластику, замещение дефектов сухожилий аллотрансплантатами и аутотрансплантатами, пластику проксимальной капсулы плечевого сустава, мышечно-сухожильные трансферы и эндопротезирование плечевого сустава. Однако, по данным литературы, частота повторных разрывов после хирургического вмешательства составляет от 11 до 94 %. Несмотря на большое количество методов лечения массивных разрывов вращательной манжеты плеча, отсутствуют чёткие алгоритмы ведения пациентов и выбора той или иной хирургической тактики. Кроме того, сохраняется высокий процент неудовлетворительных исходов лечения. Учитывая всё вышесказанное, проблема совершенствования лечения таких пациентов остаётся актуальной и своевременной.

Ключевые слова: *вращательная манжета, хирургическое лечение, массивные разрывы, сухожилие надостной мышцы, плечевой сустав*

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INTRODUCTION

The incidence of rotator cuff ruptures, according to the literature, ranges from 20 % to 40 %; this pathology is more common in people over 60 years of age [1, 2]. The proportion of massive ruptures of the rotator cuff ranges from 10 to 40 % of all ruptures [3, 4]. There is currently no uniform approach in defining massive ruptures of the cuff. Massive rupture, according to the literature, is an injury of two or more tendons or a rupture with a diastasis of more than 5 cm [5, 6]. The main clinical manifestations in such injuries are pain syndrome and impaired function of the shoulder joint. Patients may experience loss of active range of motion in the shoulder joint while passive motion is preserved. These ruptures change the kinematics of the shoulder joint, namely proximal subluxation of the humeral head, arthropathy of the shoulder joint, which subsequently leads to pseudoparalysis [7]. Pseudoparalysis in massive ruptures of the rotator cuff is considered to be the presence of active abduction and flexion of less than 90° with full passive range of motion in the absence of neurological impairment [8]. There is currently no unified approach to the choice of surgical treatment. The most common options can be considered: partial rotator cuff restoration; subacromial balloon angioplasty, proximal rotator cuff plasty, musculotendinous transfers; and shoulder endoprosthetics. However, according to the literature, the incidence of recurrent ruptures after surgery ranges from 11 % to 94 % [9, 10].

THE AIM OF THE STUDY

To analyze the literature data of foreign and domestic authors and provide an overview of modern concepts of surgical treatment of massive ruptures of the rotator cuff.

MATERIALS AND METHODS

A literature search of foreign and domestic authors was performed using PubMed and eLibrary using the following keywords: "rotator cuff", "surgical treatment", "massive ruptures", "tendon of the supraspinous muscle", "shoulder joint" and their English-language counterparts. Publications between 2004 and 2023 were analyzed.

PARTIAL RESTORATION OF MASSIVE RUPTURES OF THE ROTATOR CUFF

The technique of partial restoration in massive ruptures of the rotator cuff was first proposed by S.S. Burkhart in 1994. This method involved restoration of most of the damaged tendons to partially restore shoulder function. S.S. Burkhart et al. performed partial restoration of rotator cuff in 14 patients. Patients after surgical treatment were observed to have an improvement in active abduction from 91° to 150°. Functional outcome according to The University of California – Los Angeles Shoulder Scale (UCLA) improved from 10 points preoperatively, to 28 points after surgical treatment [11]. Partial restoration was originally proposed as open surgery, but advances in minimally invasive technology have made it possible to perform this surgery arthroscopically. This treatment is indicated in patients with massive rupture of the supraspinous muscle tendon and repairable ruptures of the infraspinous and subscapularis tendons [12]. According to the literature, the incidence of recurrent rupture after partial restoration is high at 48.9 % [13]. Good functional results are believed to be short-term and dependent on adjunctive treatments such as subacromial decompression, sanatization, bursectomy, tenotomy or biceps tenodesis [14]. However, O. Galasso et al. in their study demonstrated an improvement in functional performance after partial rotator cuff reconstruction from 39.1 ± 8.4 to 76.3 ± 9.7. 87.4 % of patients were satisfied with the results of treatment [15]. J.D. Hallock et al. found that 4.5 years after partial cuff restoration, revision interventions were required in 5.2 % of patients, with 87 % not requiring reoperative interventions [16]. M.S. Shon et al. reported that after 2 years of follow-up, 50 % of patients showed no improvement after partial reconstruction with decreasing ASES (American Shoulder and Elbow Surgeons) scores [17]. S.J. Kim et al. published the results of 27 patients who underwent partial restoration of the rotator cuff. The mean preoperative rupture size was 42.1 mm and the mean postoperative defect size was 12.0 mm. Functional UCLA outcome improved from 10.5 preoperatively to 25.9 postoperatively [18]. N.D. Iagulli et al. compared partial restoration of rotator cuff versus complete restoration for massive ruptures. The follow-up period was 24 months. The assessment was performed using the UCLA scale. No significant differences were observed in the two groups [19]. M. Moser et al. in their study which compared partial versus full cuff restoration noted that external rotation was significantly better with full restoration. However, the severity of pain and functional outcome were not statistically significant [20].

Consequently, partial restoration of the rotator cuff results in improved functional outcomes and reduced pain in the short term and is suitable for the treatment of patients with low functional needs [21].

BIODEGRADABLE SUBACROMIAL SPACER

An option for surgical treatment of massive ruptures of the rotator cuff is arthroscopic placement of a biodegradable subacromial spacer. The essence of surgical treatment is the introduction of a balloon spacer into the subacromial space, which is subsequently filled with physiologic solution. This device is designed to increase the acromiohumeral interval, lower the humeral head, and thereby eliminate secondary subluxation. The average lifespan of this device is 6–12 months, followed by device degradation [21]. V. Senekovic et al. conducted a prospective study of 20 patients who had been implanted with a biodegrad-

able spacer. The follow-up period was 5 years. Functional improvement was observed in 84.6 % of cases. E. Gervasi et al. suggested in their study that it is not necessary to perform subacromial decompression before balloon positioning. Other authors, however, argue that subacromial decompression should be performed in order to rule out other sources of pain, as well as to select an appropriate balloon size. Some studies have also found that spacer insertion is not indicated for ruptures of the subscapularis tendon, as there is a high risk of balloon migration. In other studies, satisfactory results were obtained when reconstruction of the subscapularis muscle tendon and spacer insertion were performed [21–23]. M. Holschen et al. performed rotator cuff sanation in 11 patients, and 12 patients underwent joint sanation with subacromial spacer insertion. The follow-up period was 23 months. Statistically significant improvement ($p < 0.001$) was observed in the group with spacer insertion. There is doubtful about the results of this study since no randomisation is available [24]. J. Deranlot et al. have assessed the results of arthroscopic balloon plasty in 37 patients. The mean follow-up was 32.8 months. Patients had a significant increase in the range of movements compared to the preoperative period. Active flexion increased from 130° to 160°, active abduction increased from 100° to 160°, and external rotation increased from 30° to 45°. In the presence of good functional results, however, a decrease in the acromiohumeral interval from 8.2 mm preoperatively to 6.2 cm at final follow-up was radiologically observed [25]. M.A. Malahias et al. conducted a comparable study of 32 patients. The first group underwent partial restoration of rotator cuff combined with subacromial spacer insertion. The second group underwent only partial restoration of the rotator cuff. All patients experienced improved functional outcomes and pain reduction after 12 months, but no statistically significant differences were found between the two groups [26].

Arthroscopic insertion of a biodegradable spacer is a minimally invasive procedure in the treatment of patients with massive ruptures of the rotator cuff. This surgical technique results in reduced pain, improved functional outcomes. This procedure, however, is suitable for elderly patients with low physical activity, as it does not eliminate the cause, namely the rotator cuff rupture itself. And the implant "survival" period ranges from 6 to 12 months.

REPLACEMENT OF TENDON DEFECTS WITH GRAFTS

Allograft replacement of the tendon defect is another treatment option for massive ruptures of the rotator cuff. Xenografts are used as allografts. M.H. Metcalf et al. first reported the use of xenotransplants for the treatment of massive ruptures of the cuff. Twelve patients were involved in the study. The follow-up period was 2 years. Complete graft engraftment was observed in 11 patients according to magnetic resonance imaging (MRI) data. Complete resorption of the graft was observed in one patient. No infectious complications were observed. The functional UCLA outcome increased from 9.9 to 19.9 points, but shoulder joint function remained below normal [27]. S.P. Badhe et al. conducted a prospective study of 10 patients with massive ruptures of the rotator cuff who underwent xenograft replacement of the defect. All patients experienced a significant reduction in pain as well as an increase in range of motion. According to ultrasound findings, graft destruction was observed in two patients [28].

Dermal allografts are also used to replace defects. W.Z. Burkhead et al. used a cell-free dermal collagen matrix to restore massive ruptures in 17 patients. The mean follow-up period was 24 months. Mean UCLA scale scores improved from 9.06 to 26.12 points. Unsatisfactory treatment results were observed in 3 patients [29]. J.L. Bond et al. performed arthroscopic implantation of cell-free dermal collagen matrix in 16 patients with non-restorable rotator cuff ruptures. The mean follow-up period was 26.7 months. 15 out of 16 patients were satisfied with the treatment. The average UCLA scale score increased from 18.4 to 30.4 points. According to MRI data, complete graft engraftment was observed in 13 patients [30]. A.K. Gupta et al. have followed 24 patients with a mean follow-up of 36 months. There were improvements in ASES scale scores from 66.6 to 88.7 during the follow-up period. Visual analogue scale (VAS) scores decreased significantly over the follow-up period, from 5.4 to 0.9 points. A statistically significant improvement in active abduction and active flexion at the shoulder joint was observed [31]. P.J. Denard et al. analyzed 59 patients who underwent plasty with cell-free dermal collagen matrix. The follow-up period was 1 year. Functional outcome was assessed using the ASES scale. Flexion improved from 130° to 158° postoperatively. Pain was assessed using the VAS. Pain syndrome decreased from 5.8 to 1.7 points. The acromiohumeral interval increased from 6.6 to 7.6 mm, but decreased again to 6.7 mm 2 weeks after surgery. 70 % of patients were satisfied with the treatment. Based on postoperative MRIs, 45 % of cases had complete graft engraftment and 74.6 % of cases were considered successful. Revision surgeries were performed in 18.6 % of cases, of which 7 patients underwent reverse endoprosthesis [32]. S. Lee et al. noted a decrease in the acromiohumeral interval as a sign of dermal graft failure [33]. In 2012 T. Mihata et al. proposed and described the technique of arthroscopic reconstruction of the upper rotator cuff using an autograft of the fasciae latae muscle. The essence of this method was fixation of the proximal edge of the autograft to the articular process of the scapula rather than to the retracted tendon stumps. The other end of the graft was fixed to the tuberculum majus humeri. This technique improves the correction of proximal subluxation of the head of the humerus (caput humeri) and the prevention of shoulder arthropathy. T. Mihata et al. conducted a study of 24 patients who underwent reconstruction of the upper part of the rotator cuff with an autograft of the fasciae latae muscle. The follow-up period was 2 years. 83.3 % of patients experienced good functional outcomes, namely abduction and external

rotation. The acromiohumeral increased from 4.6 mm preoperatively to 8.7 mm postoperatively [34, 35]. R.W. Jordan et al. performed a systematic review of the literature of reconstruction in upper part of the rotator cuff of the fasciae latae muscle and cell-free dermal collagen matrix. 9 studies were included in the review. Five studies reported grafting with the fasciae latae muscle, and four studies focused mainly around a cell-free dermal collagen matrix. The average follow-up time ranged from 10.9 to 42.4 months. The results were assessed using X-ray techniques. The incidence of dermal matrix failure ranged from 5.5 to 55 %, and fasciae latae muscle failure ranged from 4.2 to 36.1 % [36]. Y.S. Kim et al. published a method of plasty of the proximal rotator cuff with the long head of the biceps tendon. The essence of this surgical intervention is to move the long head of the biceps tendon to the tuberculum majus humeri, which helps to increase the acromiohumeral interval. The preference of this "all-inside" technique is that it is technically less demanding and the use of autograft reduces infectious risks [37, 38].

N.N. Chirkov in 2019 proposed a new method of arthroscopic restoration of the supraspinatus tendon integrity with the autotendon of the long peroneal muscle. The method involves fixation of a tendon autograft, which is passed through the soft tissues of the retracted tendons and fixed with spud legs on a tuberculum majus humeri [39]. N.N. Chirkov et al. published a study comparing partial restoration of the rotator cuff with autotendinous reconstruction of the long peroneal muscle. A total of 58 individuals participated in the study. The patients were divided into two groups. The first group was 30 patients who underwent partial restoration of the rotator cuff. The second group was 28 patients who underwent rotator cuff reconstruction according to the previously described method. The results were evaluated on the scales of VAS, UCLA, ASES, CS (Constant Shoulder Score). Patients in the second group had better functional outcomes. Good and excellent results in the second group of patients were observed in 53.6 % of cases, while in the first group the figure was 26.7 %. Revision surgeries were required in 4 patients, two of whom underwent reverse prosthesis because of advanced osteoarthritis. No complications were observed in both groups [40].

The replacement of rotator cuff tendon defects with both autografts and allografts is currently receiving much attention. Patients have good functional outcomes and pain reduction, but there remains a high rate of graft failure.

MUSCULOTENDINOUS TRANSFERS

If the articular cartilage of the humeral head is preserved, musculotendinous transfers represent one of the surgical options. The most common is the transfer of the latissimus dorsi tendon. In 1998, C. Gerber was the first to suggest and perform latissimus dorsi tendon transposition to the head of the humerus in massive ruptures of the rotator cuff. The essence of surgical treatment was to change the force vector and lower the head of the humerus. In their study, C. Gerber et al. reported 74 % of good and excellent clinical outcomes with a follow-up period of 10 years [41]. S. Namdari et al. conducted a systematic literature review between 1992 and 2010 to determine the outcomes of latissimus dorsi tendon transposition. Ten studies were analysed, with a mean follow-up of 45.5 months. Functional scores improved from 45.9 to 73.2 points. There was an improvement in flexion from 101.9 to 130.7° postoperatively. The overall reported complication incidence was 9.5 %; these included infectious complications, neuropathy, ruptures of transferred tendons, haematomas, and wound disruption [42].

The main factors contributing to a better outcome after latissimus dorsi tendon transposition are preserved or reconstructable sublumbar tendon, absence of deltoid muscle dysfunction, preservation of passive movements in the shoulder joint, and absence of signs of severe osteoarthritis [43]. Researchers believe that irreparable damage to the tendon of the subscapularis muscle is an absolute contraindication to latissimus dorsi tendon transposition, as the centring effect of the rotator cuff muscles is lost [44, 45]. In 2003 E. Gervasi et al. proposed arthroscopic-assisted latissimus dorsi tendon transposition. This technique is minimally invasive, as a result, the risks of traumatization of the acromiohumeral muscle and iatrogenic damage to the neurovascular bundle are reduced. Reducing the risk of injury to the acromiohumeral muscle contributes to the preservation of muscle strength and earlier rehabilitation of patients [46].

S.Y. Dokolin et al. proposed a new method of arthroscopic-assisted latissimus dorsi tendon transposition. Features of the technique include the placement of an additional suprapectoral arthroscopic port, which is necessary to sever the tendon at the crest of the humerus. The tendon of the latissimus dorsi is also augmented with an allograft from the iliotibial tract. Next, the formed graft is passed between the acromiohumeral muscle and teres minor muscle and fixed on the head of the humerus using spud legs. This method reduces the risks of damage to the neurovascular bundle and also reduces the likelihood of postoperative graft detachments [47].

N.V. Zagorodny et al. proposed the technique of double tendon transposition as a method of treatment of non-restorable, massive ruptures of the rotator cuff. Surgical treatment was performed arthroscopically with additional access in the subaxillary region. The essence of this surgery was to excise the tendons of the latissimus dorsi and greater teres muscles from their attachment site and transpose them with fixation to the tuberculum majus humeri. Surgical treatment is performed in an arthroscopically assisted manner with additional access to the subaxillary region to mobilize the latissimus dorsi and teres major muscle. Five patients were underwent surgery using this technique. The follow-up period was 5 ± 1 month. Significant improvement in functional outcomes was observed after surgical treatment. Flexion ranged from 140 to 170° and abduction from 140 to 176°. On the UCLA scale, the mean score changed from 12 to 22.5. Good to satisfactory outcomes were reported in all five patients [48].

Muscle-tendon transfers can be considered the technique of choice for young and active patients. The risk of iatrogenic damage to the neurovascular bundle when excising the tendon from the crest of the humerus remains high, however, as well as the risks of graft detachment both after primary transposition and after revision intervention.

REVERSE SHOULDER REPLACEMENT

Another treatment option for massive ruptures of the rotator cuff is reverse shoulder replacement. Common indications for endoprosthesis are pain and "pseudoparalysis" of the rotator cuff that develops from massive ruptures of the rotator cuff. According to the authors, endoprosthesis is not suitable for the treatment of young and active patients, since there are functional limitations of the shoulder joint, as well as rapid wear of the endoprosthesis, respectively, there is a high probability of upcoming repeated revision surgical interventions [49]. According to the literature, there is a significant reduction in pain syndrome after reverse endoprosthesis, but there is a limitation of flexion to 117–121°. The incidence of complications after this surgery is 33–50 %. Repeated revision interventions comprise 8.3–9.0 %. The most frequent complications include periprosthetic infections (0–6 %), endoprosthesis instability and dislocation (0–30 %), and periprosthetic fractures (1–2 %). Considering the high risk of complications, caution should be exercised when performing reverse replacement arthroplasty in young, active patients [50].

CONCLUSION

The analysis of literature data revealed advantages and disadvantages of existing operative methods of treatment of patients with massive ruptures of the rotator cuff. A high percentage of unsatisfactory treatment outcomes remains regardless of the large number of surgical techniques proposed. No clear algorithms for the choice of a particular surgical tactic are available. Having taken all the above into account, it becomes clear that the problem of improving the treatment of such patients currently remains urgent and requires additional efforts to solve.

Conflict of interest

The author of this article declares that there is no conflict of interest.

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