ROTATOR CUFF TENDON RUPTURES (LITERATURE REVIEW)

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ABSTRACT

Rotator cuff injury is a common disorder: up to 20 % of the population over the age of 45 have tears of varying severity, of which up to 40 % are large and massive ruptures. The gradual development of tendon degeneration and fatty degeneration of muscle tissue and the asymptomatic course of the disease often lead to late medical attention when secondary arthropathy of the shoulder joint develops. With age, the probability of having a rupture increases, reaching 51 % in people over 80 years of age. The main diagnostic tools are radiography and magnetic resonance imaging of the shoulder joint combined with clinical examination. Nonsurgical treatment for massive injuries is ineffective, and the risk of worsening rotator cuff tendinopathy to rupture reaches 54 %. There are three main directions in the surgery of rotator cuff injuries: tendon reconstruction or replacement of their defect with grafts; muscle transfer; shoulder arthroplasty. Subacromial balloon spacer and tenogenic patches are also used. Each of these methods has a number of disadvantages and limitations. The frequency of repeated ruptures of reconstructed tendons reaches 45 %. Muscle transfer is extremely demanding on the skill of the surgeon and is associated with high risks of neurological complications. Arthroplasty imposes a number of significant restrictions on the patient, reducing the quality of life, and prosthesis components wear increases the risk of complications, especially during revision interventions. The use of the subacromial spacer is limited by its high cost and lack of long-term follow-up of treatment outcomes. Tenogenic patches have not undergone clinical trials, being an experimental technique.

There is no single approach to the treatment of massive rotator cuff ruptures. The results are contradictory, the advantages of each of the methods are balanced by their disadvantages, which provides a wide window of opportunity in the studying, optimizing classical and introducing new methods of treatment of this pathology.

Key words: *rotator cuff, surgical treatment, conservative treatment, massive ruptures*

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ПОВРЕЖДЕНИЯ ВРАЩАТЕЛЬНОЙ МАНЖЕТЫ ПЛЕЧА (ОБЗОР ЛИТЕРАТУРЫ)

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РЕЗЮМЕ

Повреждение вращательной манжеты – распространённое заболевание: до 20 % населения старше 45 лет имеют разрывы разной степени выраженности, из них до 40 % – большие и массивные. Постепенное развитие процессов дегенерации сухожилий и жировой дистрофии мышечной ткани и бессимптомное течение заболевания часто приводят к поздним обращениям за медицинской помощью, когда развивается вторичная артропатия плечевого сустава. С возрастом вероятность наличия разрыва увеличивается, достигая 51 % у лиц старше 80 лет. Основными инструментами диагностики являются рентгенография и магнитно-резонансная томография плечевого сустава в совокупности с клиническим осмотром. Консервативное лечение при массивных повреждениях малоэффективно, а риск усугубления тендинопатии вращательной манжеты до разрыва при нём достигает 54 %. В хирургии повреждений вращательной манжеты плеча можно выделить три основных направления: восстановление сухожилий или замещение их дефекта трансплантатами; мышечный трансфер; эндопротезирование плечевого сустава. Также применяются субакромиальной баллонный спейсер, теногенные пластыри. У каждого из методов есть ряд недостатков и ограничений. Частота повторных разрывов рефиксированных сухожилий достигает 45 %. Мышечный трансфер крайне требователен к квалификации хирурга и сопряжён с высокими рисками неврологических осложнений. Эндопротезирование накладывает ряд существенных ограничений на пациента, снижая качество жизни, а износ компонентов протеза увеличивает степень риска осложнений, особенно при ревизионных вмешательствах. Применение субакромиального спейсера ограничено его высокой стоимостью и отсутствием длительного наблюдения за результатами лечения. Теногенные пластыри не проходили клинических испытаний, являясь экспериментальной методикой.
Таким образом, единого подхода к лечению массивных разрывов вращательной манжеты не существует, результаты противоречивы, преимущества каждой из распространённых методик уравновешиваются недостатками, что предоставляет широкое окно возможностей в области изучения, оптимизации классических и внедрения новых методов лечения данной патологии.

Ключевые слова: *вращательная манжета, хирургическое лечение, консервативное лечение, массивные разрывы*

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INTRODUCTION

Rotator cuff injury is the most common pathology of the shoulder joint: up to 20 % of the population over 45 years of age have ruptures of various degrees of severity, of which up to 40 % have large and massive ruptures [1]. The disease is often asymptomatic and in only one third of patients is accompanied by pain and dysfunction of the affected shoulder joint [2]. The prevalence of rotator cuff ruptures increases with age since degenerative changes in the tendon will prevail with increasing age, occurring in 20 % of people aged 60 to 69 years, 31 % of those aged 70 to 79 years and 51 % of those over 80 years [3, 4].

The most severe category of rotator cuff tendon ruptures in terms of prognosis is massive, non-repairable ruptures, which account for up to 40 % of all ruptures. It is caused by the impossibility to perform reinsertion of rotator cuff tendons on the insertion surface, and even in case of partial adaptation of the damaged tendon, the muscle remains unable to fulfil its function as a result of fatty degeneration, the consequence of which is progressive arthropathy of the shoulder joint [5]. Currently, there are many ways to treat patients with massive, irreparable tendon ruptures of the rotator cuff with their own advantages and disadvantages, and each surgeon prefers one or another technique as a result of his or her experience and professional skills, and there is currently no single consensus and algorithm for the treatment of this severe pathology.

Several criteria shall be carefully considered in order to determine the treatment tactics and choose the optimal surgical approach: the degree of proximal displacement of the humeral head, which is reflected in the radiological classification by K. Hamada; the degree of retraction of the supraspinous muscle tendon and assessment of the volume of tendons involved in the injury according to the D. Patte classification; MRI classification of the fatty dystrophy degree of the rotator cuff muscles according to D. Goutallier; MRI classification of supraspinous muscle atrophy by H. Thomazeau.

The classification of K. Hamada, proposed by him in 1990, is based on the acromiohumeral interval AHI and the degree of degenerative changes in cartilage and subchondral bone of the articular cavity of the scapula and humeral head: stage I – AHI > 6 mm; stage II – AHI < 5 mm; stage III – concave deformation of the acromial scapular process (acetabulation) with AHI; stage IV – acetabulation with narrowing of the subacromial space; stage V – collapse of the humeral head. This classification primarily reflects the degree of shoulder arthropathy, which is of principal importance when indicating endoprosthesis replacement. The extent of rotator cuff tendon injury according to this classification is determined empirically, but it is always massive, as only such lesions cause X-ray significant changes in the position of the humeral head [6].

The D. Patte classification, proposed by him in 1990, assesses the degree of retraction of the rotator cuff tendons in the frontal plane and the involvement of the rotator cuff elements in the sagittal plane based on the results of magnetic resonance imaging (MRI). In the first case, D. Patte distinguished three stages: stage I – tendon stump is located near the place of attachment to the humerus; stage II – tendon stump is located at the level of the humeral head; stage III – tendon stump is located at the level of the glenoid. The stage directly indicates the length of time that has elapsed since the rotator cuff tendon detached from the shoulder and the degree of retraction of the corresponding muscle. In the second case, six segments were identified: segment 1 – isolated tendon injury of the subscapular muscle; segment 2 – isolated rupture of the coracohumeral ligament; segment 3 – isolated tendon rupture of the supraspinous muscle; segment 4 – complete rupture of the supraspinous muscle and partial rupture of the infraspinatus muscle tendon; segment 5 – complete rupture of the tendons of the supraspinous and infraspinatus muscles; segment 6 – complete rupture of the tendons of the supraspinous, infraspinatus and subscapular muscles [7].

The D. Goutallier classification, proposed by him in 1994, assesses the degree of fatty dystrophy of the rotator cuff muscles by dividing it into four stages: stage 0 – normal, unchanged muscle tissue; stage 1 – insignificant fat layers in the muscle thickness; stage 2 – the volume of fat layers is less than 50 % of the muscle volume; stage 3 – the volume of fat layers is 50 %; stage 4 – the volume of fat layers is more than 50 % of the muscle volume [8].

As opposed to this, H. Thomazeau et al. in their classification, proposed in 1996, assess the degree of fatty dystrophy of the supraspinous muscle by the volume of muscle tissue, distinguishing three stages: stage 1 – normal or mild atrophy (muscle tissue volume – 60–100 %); stage 2 – moderate atrophy (muscle tissue volume – 40–60 %); stage 3 – severe atrophy (muscle tissue volume – less than 40 %) [9].

DIAGNOSTICS

Clinical examination, X-ray, ultrasound and MRI of the shoulder joint are the main methods used to diagnose rotator cuff injuries.

The clinical picture of the disease is dominated by pain syndrome, impaired abduction, flexion and rotation of the shoulder, as well as decreased strength in the affected arm. The history usually includes a fall on an outstretched arm or excessive physical exertion. The professional activities associated with prolonged work with arms raised upwards or in static tension of the thoracic girdle being one of the factors. During visual examination, asymmetry of the shoulder joints as a result of muscle hypotrophy of the deltoid and infraspinatus muscles is observed. Assessment motion test (simultaneous abduction and raising of both hands, raising hands behind the head and putting them behind the back) and comparison of the range of active and passive motions allow to reveal the functional deficit and its degree. Resis-

tive tests allow a more accurate localisation of the injury by the appearance of pain when counteracting active hand motions. Pain in resistive abduction indicates a tendon of the supraspinous muscle, in resistive external rotation – tendon of the infraspinatus muscle, in resistive internal rotation – tendon of the subscapularis muscle. A "falling arm" positive test (smooth lowering of the arm from the abduction position up to 120° is not feasible) also indicates rotator cuff damage [10–12].

Comparative X-ray of both shoulder joints in direct projection will be uninformative in small ruptures, but in old large and massive ruptures the clear signs will be a decrease in the height of the subacromial space and upper subluxation of the humeral head. This examination method also reveals the presence and degree of arthropathy developed as a result of rotator cuff rupture (according to K. Hamada classification).

Ultrasound examinations are of little use in routine practice. Generally, this method is used when there are contraindications with an MRI. In large and massive tendon injuries, its accuracy and specificity are higher than in smaller volume injuries [13, 14].

MRI is currently the most informative and used diagnostic method. Its accuracy and specificity are maximised as a result of the clear visualisation of soft tissue structures and the possibility of evaluating the image in all dimensions. Apart from being able to directly visualise the area of injury, it is possible to assess its volume, the degree of tendon retraction and the degree of muscle fatty dystrophy. The use of classifications assessing these parameters (Patte, Thomazeau) facilitates the prediction of the course of the disease and the planning of a particular treatment method.

NONSURGICAL TREATMENT

Nonsurgical treatment of rotator cuff tears is primarily intended to improve quality of life by reducing pain, strengthening the shoulder girdle muscles, resulting in stabilisation of the shoulder joint and increased range of motion. Therapies include physical therapy, local injection therapy, and physiotherapy. Unfortunately, this approach requires a long period of time and its effectiveness is not high enough. In 2015, C. Schmidt et al. analyzed the effectiveness of this method. The course of nonsurgical treatment was followed for 3 months, with 75 % of patients experiencing improvement between the 6th and 12th week of treatment, but 25 % of patients did not show a positive effect of therapy and underwent surgical treatment [15]. P.O. Zingg et al. in their study also indicate that despite the apparent positive effect, its duration is not to be long-term [16].

Local injection therapy with glucocorticosteroid preparations, despite the rapid achievement of analgesic effect, is associated with the risk of aggravation of degenerative processes in the tendon tissue, its loosening and the appearance of local necrosis [17]. The use of hyaluronic acid preparations in this pathology also demonstrates low efficacy, requires prolonged use and is unable to ensure the absence of pain syndrome recurrence for a long period of time [18].

Among patients with symptomatic rotator cuff tendinopathy persisting for at least 1 year, 39 % had progression to partial or complete rupture by follow-up MRI. When patients were grouped by time between scans (1 to 2 years, 2 to 5 years, or more than 5 years), the incidence of tendinopathy before rupture was 32 %, 37 %, and 54 %, respectively [19].

SURGICAL TREATMENT

There are three main areas of surgery in rotator cuff injuries: tendon restoration, muscle transfer and shoulder endoprosthesis replacement.

The first mention of surgical treatment in rotator cuff injury is over a century old. In 1911, A. Codman performed open tendon reinsertion to the humerus. Further development of the technique was proposed by N. McLaughlin, O. Debeyre and D. Patte, who performed an extensive release of the injured tendons and muscles with their complete excision from the scapula body and subsequent covering of the defect. The rapid spread of arthroscopic techniques and the advent of anchor fixators has revolutionized reconstructive shoulder surgery since the 1990s [20]. Acute, long-standing partial injuries may respond well to this method, but in massive defects with significant tendon retraction and marked fatty muscle dystrophy, the risk of recurrence is significantly increased [21]. According to J.C. Yoo et al. the incidence of recurrent ruptures during arthroscopic refixation reaches 45.5 % [22]. A study conducted by A. Green et al., consisting of a long-term (up to 15 years) follow-up of a patient group aged up to 61 years, revealed that functional outcomes assessed by questionnaire were relatively stable at long-term follow-up after rotator cuff restoration irrespective of instrumentally confirmed tissue deterioration, and few statistically significant relationships between structural and functional outcomes were found. This indicates that rotator cuff restoration is not effective in stopping the progression of degenerative processes, but can slow it down, as well as that patients adapt to structural changes with age and preserve a subjectively high level of their life quality [23].

As a result, the idea of plasty of massive ruptures with significant tendon rupture with grafts from similar tissues of the patient or with allografts of dermal matrix was further developed. According to J.L. Bond et al. the frequency of allograft rejection reaches 36 % [24, 25]. Notwithstanding these reasons, the allograft is widely used in foreign practice, particularly as a consequence of its higher strength characteristics in comparison with own tendon tissues [26]. Often this intervention is combined with acromioplasty to reduce graft pressure in the subacromial space. Furthermore, T. Mihata in 2012 proposed capsuloplasty with fixation of the proximal edge of the graft not to the tendon stump of the rotator cuff, but directly to the articular process of the scapula. In this way,

a "hammock" effect is obtained, centring the head relative to the articular socket of the scapula [27, 28].

Muscle transfer has also emerged as an answer to the problem of long-standing massive rotator cuff injuries. It was first used by J. I'Erissoro, who in 1934 performed transposition of tendons of the latissimus dorsi and teres minor muscle in a patient with Duchenne-Erb's palsy. Further development of the technique using different variations of the transfer was proposed by C. Gerber and A. Gilbert., who finally came to an isolated open transposition of the latissimus dorsi tendon in 1988 in order to restore external rotation of the shoulder and provide shoulder abduction due to the work of the deltoid muscle [29]. Thanks to improvements in surgical technique in 2003 E. Gervasi performed arthroscopically associated transposition of the latissimus dorsi tendon. However, this method has not been widely used in practice since its technical complexity and high requirements for the surgeon's qualification [30]. Even less common is the greater pectoral muscle tendon transfer proposed by M.A. Wirth and S.A. Rockwood in 1997. The statistics collected by various authors are contradictory. The authors note a high success rate (up to 84 %) in primary intervention, but at the same time a high probability of graft rupture at the site of its fixation to the humerus (up to 38 %) and up to 61 % of complications in revision surgeries.

Shoulder endoprosthesis replacement serves as an alternative to reconstructive surgery and muscle transfer. This surgery was first performed in 1893 by J.E. Pean. Having undergone many evolutions in both prosthetic concepts and surgical techniques, three main types of prosthetics have now emerged: anatomical, superficial, and reverse prosthetics. Anatomical and superficial prosthetics involve preserving the integrity of the rotator cuff, while reverse prosthetics are applicable in cases of rotator cuff injuries, including shoulder arthropathy. The first mention of this type of prosthesis was made in 1972 by B. Reeves. Although it was not used in clinical practice, the design served as a source of further technique development until 1987, when P.M. Grammont proposed his reversible system, the main advantage of which was optimal involvement of the deltoid muscle, which compensated for the deficit of abduction associated with rotator cuff dysfunction. Modern reversible Delta shoulder prostheses, the prototype of which is the Grammont prosthesis, are widely used in world practice [31]. Chronic pain syndrome and pseudoparalysis of the upper extremity, which are manifestations of arthropathy of the shoulder joint developed as a consequence of a large or massive rupture of the rotator cuff, constitute the main indications for reverse endoprosthesis replacement. Recently, the indications for this surgery have been expanding to include massive non-repairable rotator cuff ruptures without signs of degeneration and destruction of the cartilage of the humeral head and articular surface of the scapula [32]. It is associated primarily with the accumulation of positive statistics about the effectiveness of this intervention. However, there are disadvantages of endoprosthesis replacement that significantly limit its use. First of all, it is a significant limitation of loads on the prosthetic extremity, which is unacceptable in young patients with a high level of physical activity. The range of motion in the shoulder joint is also reduced, especially its flexion. A further negative factor involves the need to perform revision surgeries as the prosthesis components wear out mechanically. There is a high risk of implant instability, dislocation, paraprosthetic infections, especially in the case of rheumatoid joint surgery. The incidence of complications in reverse shoulder endoprosthesis replacement after massive rupture of the rotator cuff and concomitant arthropathy can be as high as 20 % according to some reports [33, 34].

The use of a subacromial balloon spacer should be emphasised separately. This method was first described by E. Savarese and R. Romeo in 2012. The essence of the method consists of inserting a biodegradable inflatable balloon into the subacromial space after revision of the subacromial space, which pushes the humeral head downwards, thus levelling the subacromial conflict. An obvious advantage of it lies in the least complicated and least traumatic surgical technique as compared to classical techniques. At the same time, however, its mass application has significant limitations that narrow the indications for its use: preserved active shoulder abduction up to 90°; intact tendon rupture of the teres minor muscle; absence of arthropathy of the shoulder joint on the background of the rotator cuff massive rupture; patient's age over 65 years [35].

Also noteworthy is the development of tenogenic patches (TENOPatch), which serve as a matrix for the formation of collagen fibres binding tendon residual limb and bone. The technique has been tested using laboratory animals, but has not been subjected to clinical trials [36].

CONCLUSION

Surgery of massive rotator cuff injuries is a dynamic branch of modern orthopedics. MRI and modern optics have made it possible to make a qualitative transition in the diagnosis and treatment of this pathology, and provided a key in understanding the biomechanics of the shoulder joint, the reasons for the aggravation of the pathological process and the development of complications. There are still unresolved issues, however, the methodologies used are imperfect, the advantages of each are balanced by the disadvantages, and the advantages are not obvious. Literature data are often conflicting in assessing treatment outcomes. The combination of these circumstances provides a wide world of opportunities in the field of research, optimisation of classical and introduction of new methods of treatment of this pathology. In the authors' opinion, the rational approach is sequential treatment with a preference for organ-preserving interventions; shoulder endoprosthesis replacement remains a last resort when other surgical options have been exhausted.

Conflict of interest

The authors of this article declare no conflicts of interest.

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