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A Retrospective Longitudinal Study: Investigate The Influence of Diabetes Mellitus on The Retears After Arthroscopic Rotator Cuff Repair

Wenjie Luo *

Chendu Sports University, Chengdu, 610041, China

* Corresponding Author Email: maojiangbo@ldy.edu.rs

Abstract. This investigation aims to assess the impact of inadequate glycemic control on the occurrence of postoperative retear in patients diagnosed with rotator cuff pathology, with a particular focus on individuals with a pre-existing diagnosis of diabetes mellitus. A retrospective analysis was performed on a sample cohort consisting of 60 diabetic patients who had undergone arthroscopic rotator cuff repair. Glycemic control was deemed suboptimal in 32 subjects, characterized by a glycosylated hemoglobin (HbA1c) concentration ≥7.0%, while 28 subjects were identified as having effective glycemic regulation, as evidenced by HbA1c levels <7.0%. A six-month follow-up period was maintained for patient monitoring. Tendon integrity and the incidence of re-ruptures were assessed via magnetic resonance imaging (MRI), utilizing pre-established MRI criteria to identify re-tears. The employment of directed prophylactic and therapeutic measures may potentially reduce the incidence of postoperative retear events within this specific patient cohort. In the diabetic patients, effective glycemic control was associated with the better rate of healing after rotator cuff repair.

Keywords: Diabetes; arthroscopy; rotator cuff injury; rotator cuff repair.

1. Introduction

A rotator cuff tear is a common injury affecting the rotator cuff complex, representing the primary upper extremity condition addressed by orthopedic surgeons. This injury substantially diminishes shoulder joint function and markedly impacts the patient's quality of life. The rotator cuff consists of four muscles: the supraspinatus, infraspinatus, teres minor, and subscapularis. The posterior superior region of the rotator cuff, comprising the supraspinatus and infraspinatus muscles, is a common site for rotator cuff tears. These injuries manifest across a continuum, from tendinopathies to complete tears, frequently in conjunction with arthritic alterations. The majority of rotator cuff injuries are degenerative in origin, although a smaller subset arises from trauma. Minor tears may remain asymptomatic, and there are instances where patients with more extensive tears do not present with detectable clinical signs. The historical understanding of the pathology associated with rotator cuff tears has been inadequate, often resulting in their mischaracterization as other forms of inflammatory conditions. Misdiagnosis has impeded the opportunity for timely intervention, which has significantly compromised the rehabilitation of shoulder function during the chronic phase. Advances in medical technology and diagnostic approaches have improved the medical community's understanding of rotator cuff tears. The prevalence of rotator cuff tears is rising in conjunction with the demographic transition towards an older population, the refinement of diagnostic and therapeutic methods, and the implementation of advanced ancillary diagnostic tools.

Rotator cuff tendon injuries generally commence with degenerative alterations, which coincide with perturbations to the extracellular matrix and inflammatory modifications. As the pathology progresses, the tissue's structural integrity becomes increasingly compromised, culminating in the transition from partial to full thickness tears. The pathogenesis of a rotator cuff rupture involves a complex interaction of both extrinsic and intrinsic factors. Extrinsic factors predominantly encompass repetitive shoulder motion, traumatic events, and the occurrence of shoulder impingement syndrome. In contradistinction, intrinsic factors encompass the aging cascade, tendinopathic conditions, muscular imbalances, and a multitude of metabolic influences. Therapeutic interventions for rotator cuff tears predominantly

focus on the degenerative modifications affecting the shoulder joint, incorporating disruptions to the extracellular matrix and associated inflammatory responses. The management of rotator cuff tears is determined by the severity of symptoms and the magnitude of the injury [1]. For patients manifesting mild symptomatology, a therapeutic regimen consisting of rest, physical therapy, and pharmacological treatments may be adopted as an initial conservative strategy. In the instance of patients experiencing minor symptoms, non-invasive therapeutic modalities such as rest, physical therapy, and medicinal management are advisable as a primary intervention.In contrast, patients presenting with more pronounced symptoms may necessitate invasive interventions, such as arthroscopic repair of the rotator cuff. Clinical evidence has established that this procedure can markedly improve pain control and reinstate joint function in afflicted individuals. Nonetheless, the occurrence of postoperative re-tears poses a persistent clinical dilemma for a proportion of patients. The prevalence of re-tear after arthroscopic rotator cuff repair has been documented to vary between 11% and 57.3% across different studies. However, the scientific literature exhibits a paucity of research into the risk factors contributing to rotator cuff re-tear subsequent to repair surgery

A variety of metabolic variables have been implicated in the onset of re-tears subsequent to the initial surgical intervention. These variables span a diverse array of biochemical pathways, encompassing inflammation, angiogenesis, and the remodeling of the extracellular matrix. The intricate interaction among these variables remains poorly elucidated, complicating the development of efficacious preventive interventions. Specifically, the relationship between diabetes mellitus and cuff disease warrants further investigation to enhance our understanding and therapeutic approaches [2-4]. Diabetes mellitus is characterized as a chronic metabolic disorder, typified by sustained hyperglycemia, which arises from disruptions in carbohydrate metabolism. It ranks among the most prevalent non-communicable diseases globally, imposing significant adverse health impacts on the affected population [5]. Furthermore, this condition not only increases the prevalence of pathologies, including rotator cuff tears, but also hampers tissue regeneration processes and enhances the organism's vulnerability to infectious agents. The adverse effects Consequently compromise the prognostic outcomes in patients undergoing arthroscopic interventions, impeding the structural integrity and functional recovery of tissues following rotator cuff repair procedures [6]. In the evaluated rat model, a marked reduction in the collagenous fibrous tissue and fibrocartilage at the tendon-bone junction was noted in diabetic rats when compared to control non-diabetic rats, concurrent with an increased accumulation of advanced glycation end products (AGEs). Hyperglycemia has the potential to induce a decrement in the synthesis of essential cytokines, either directly or indirectly, through the stimulation of oxidative stress or the synthesis of advanced glycation end products (AGEs), thus compromising the repair process of the rotator cuff tendons. Clinical research has elucidated that diabetes mellitus negatively impacts the intrinsic extracellular matrix proteins by altering cytokines, growth factors, matrix metalloproteinases, and other contributing factors.The disruption results in impaired connective tissue regeneration, reduced biomechanical properties, and prolonged duration of the tendon healing phase subsequent to injury [7,8].

This study reviews the existing literature, which has primarily concentrated on contrasting the effects of diabetes mellitus on the functional recovery post-surgery between diabetic and non-diabetic subjects. Nonetheless, there is a notable lack of investigation into the role of glycemic control in the postoperative rehabilitation process for those with diabetes mellitus. The objective of the current investigation is to conduct a retrospective analysis to assess the impact of glycated hemoglobin (HbA1c) management on the incidence of rotator cuff re-tear in diabetic patients subsequent to an initial cuff tear.

2. Methods

2.1. Case Selection

Inclusion criteria were defined as participants diagnosed with complete rotator cuff tears, which were established through a combination of clinical evaluations, magnetic resonance imaging (MRI) studies, and subsequent confirmation via arthroscopic examination. Subjects were selected based on the availability of extensive medical documentation, which included both preoperative and postoperative health data. The diabetic cohort adhered to the diagnostic criteria set forth by the World Health Organization (1999), defined by a fasting plasma glucose concentration≥7.0 mmol/L, a 2-hour postprandial plasma glucose concentration≥11.1 mmol/L, or the presence of prototypical diabetic symptoms in combination with a fasting plasma glucose concentration≥11.1 mmol/L. The cohort was stratified according to glycated hemoglobin concentration, wherein participants with levels of 7.0% or higher were categorized as having poor glycemic control, whereas those with levels below 7.0% were considered to exhibit good glycemic control.

Inclusion and Exclusion Criteria: Subjects were ineligible for participation in the study if they exhibited any of the following conditions: (1) those diagnosed with impingement syndrome in the absence of associated tendon tears were excluded, given that the pathophysiological mechanisms and treatment modalities for their shoulder complaints were substantially different from those pertaining to rotator cuff tears, which constituted the primary focus of the current research; (2) adult participants with a history of surgical treatment for benign or malignant tumors, adhesive capsulitis, shoulder instability, shoulder arthroplasty, or fractures were also deemed ineligible. The study cohort exhibited shoulder pathologies stemming from etiologies that diverged from the common causes linked to rotator cuff tears. The incorporation of these disciplines into the research protocol may have influenced the accuracy of the results. Furthermore, the analysis excluded subjects with incomplete follow-up datasets and individuals who were concurrently diagnosed with psychiatric conditions.

A total of 60 cases of rotator cuff repair for rotator cuff tear were included in this study according to the criteria for inclusion. There were 28 cases in the group with good blood sugar control, 18 males and 10 females, aged 55.10±10.87 years, and 32 cases in the group with poor blood sugar control, 17 males and 15 females, aged 53.87±12.98 years. The average follow-up time after surgery was 5.8 months.

2.2. Surgical Methods

All subjects who met the predefined inclusion criteria underwent arthroscopic repair of the rotator cuff, which was consistently executed by a solitary experienced surgeon. These participants were positioned in a beach chair orientation, with the affected upper limb abducted, under general anesthesia. A 1 cm linear incision was made 2 cm caudal and 1 cm medial to the posterolateral acromial angle. Following the initial assessment, an arthroscopic investigation of the glenohumeral joint was performed to delineate the supraspinatus muscle and to examine the infraspinatus fossa. An auxiliary incision, measuring 2 cm in length, was meticulously made along the mid-lateral border of the acromion to facilitate the insertion of the planning instrumentation and a plasma ablative knife. The rotator cuff tear was subsequently identified utilizing the arthroscopic technique. The subsequent procedural step involved the precise resection of the rupture margin, achieved with a plasma ablation device. This was followed by the meticulous smoothing of the humeral tuberosity using a planer, continuing until the bone surface presented with punctate hemorrhage. Subsequent to these actions, two to three threaded anchors were meticulously placed, with their threads drawn through the integrity-compromised tendon to enable the execution of a mattress-style suture configuration. Subsequent knotting effectively fastened the suture, ensuring its stable placement. The technique employed facilitated the reattachment of the rotator cuff tendon to the greater tuberosity of the humerus with precision. Subsequent to the outlined protocol, a standardized subacromial impingement examination was performed to evaluate the integrity of the repair. The surgical incision was meticulously approximation in a layered fashion using absorbable sutures, while a drainage

system was kept in place to aid in the removal of postoperative fluids. Postoperative immobilization was enforced for a period of four weeks in cases of small (<2 cm) and medium-sized (1-3 cm) tears, whereas a six-week immobilization was prescribed for large (3-5 cm) and very large (>5 cm) tears. All participants adhered to a uniform postoperative rehabilitation program, with clinical evaluations scheduled at 1 month, 3 months, 6 months, and 1 year after surgery, with additional follow-ups as clinically indicated. Therapeutic exercises commenced within a two-week window post-surgery, commencing with measures to control inflammation and passive range of motion (ROM) for the first six weeks, followed by a progressive program of active and active-assisted exercises. Comprehensive physical rehabilitation therapy was provided five months after surgery. Imaging studies were collected prospectively from patients at each predetermined interval, with the six-month follow-up dataset serving as the basis for the present study.

2.3. Measurement

The evaluation of the patient's postoperative recovery is based on the data obtained from magnetic resonance imaging (MRI) examinations. MRI scans of the rotator cuff typically demonstrate a uniform pattern of low signal intensity. A grade 3 signal intensity within the rotator cuff is identified as a conclusive criterion for diagnostic confirmation. The concurrent evaluation of morphological anomalies, such as cuff discontinuities and signal attenuation, in conjunction with the analysis of signal characteristics and adjacent tissue morphology, facilitates clinicians in constructing a comprehensive assessment of the patient's clinical presentation. The deployment of a dedicated surface shoulder coil markedly improves spatial resolution and the signal-to-noise ratio, which is instrumental in enabling accurate quantification of the extent of rotator cuff tendon tears and the size of the associated lesions. For the detection of rotator cuff tendon tears using magnetic resonance imaging (MRI), adherence to a rigorous consideration of diagnostic criteria, encompassing both tendon signal intensity and morphology, is essential. Assessments must be performed across various imaging slices, with specific emphasis on the supraspinatus tendon and the subscapularis muscle. Magnetic Resonance Imaging (MRI) evaluations are utilized to systematically monitor the healing trajectory of tendons in patients who are receiving post-treatment follow-up care [9,10]. The subsequent evaluation of the imaging dataset was carried out by a seasoned radiologist who possesses profound expertise in the pertinent domain. The evaluation was conducted under conditions where the radiologist was unaware of the patient's recent surgical history involving tendon repair, thus maintaining blinding with respect to the repaired tendon's dimensions and anatomical location. Tendon integrity and the prevalence of re-ruptures were examined through magnetic resonance imaging (MRI) in adherence to established MRI criteria, to determine the occurrence of a re-tear

2.4. Statistical Analysis

Statistical analyses were performed utilizing IBM SPSS Statistics version 29.0 software package for data processing and computation. A univariate logistic regression model was utilized to investigate the association between glycosylated hemoglobin concentrations and the recurrence of retearing events. Subjects who suffered from retearing were designated to Group 0, whereas individuals who did not experience retearing were allocated to Group 1. Statistical significance was established by employing a p-value threshold of <0.05.

3. Results

A univariate logistic regression was performed, employing glycated hemoglobin levels as the independent variable and the occurrence of postoperative re-tear as the dependent variable. The findings revealed that poor glycemic control emerged as an independent predictor of re-tear subsequent to rotator cuff repair, with an odds ratio of 6.000 and a 95% confidence interval of 1.172 to 30.725. Statistical significance was achieved at $P<0.05$. Refer to Table 1 for the detailed data presentation.

Table 1. Effect of Inadequate Glycemic Regulation on the Prevalence of Postoperative Rerupture in Patients Suffering from Rotator Cuff Tears

Factors	B	HERSELF	Wald	Say	OR	95%CI	
						Lower limit	Upper limit
Glycated hemoglobin	1.792	0.833	5.455	<0.05	6.000	1.172	30.725

4. Discussion

This retrospective study assessed the clinical outcomes in a cohort of 60 patients diagnosed with diabetes mellitus who also presented with concurrent rotator cuff tears. The investigation demonstrated that patients with inadequate glycemic regulation experienced an elevated rate of postoperative retears subsequent to surgical procedures. A statistically significant positive association was identified between the level of glycemic control and the frequency of retear occurrences ($P<0.05$), corroborating the results from earlier studies. Chronic hyperglycemia appears to be a significant factor that may increase the incidence of failure in rotator cuff repair procedures. Therefore, it is hypothesized that rigorous glycemic control may augment the postoperative recuperative process in individuals with a diagnosis of diabetes mellitus.

Plagued by chronic high blood sugar, diabetic patients struggle with the rehabilitation of the rotator cuff tendons, since the excessive glucose levels foster a milieu that hinders healing mechanisms. The fundamental logic behind this could be the molecular disruptions stemming from glucose-mediated oxidative stress, which results in an increase of reactive oxygen species (ROS). These ROS are capable of damaging cellular structures, such as membranes, mitochondria, and DNA. Simultaneously, this oxidative stress activates cytokines like tumor necrosis factor-α (TNF-α) and interleukin-1β (IL-1β), exacerbating the inflammatory response and enhancing tissue damage. Consequently, this inflammation hampers the critical cellular activities required for tendon repair, including the multiplication and specialization of tendon cells, thereby delaying or compromising the tendon's ability to regenerate [11].Under hyperglycemic states, glucose undergoes spontaneous reaction with proteins, resulting in the formation of advanced glycosylation end products (AGEs).The chemical alteration induces modifications in the collagen's structural integrity, which consequently exacerbates tissue stiffness and vulnerability. This manifests as a decrement in the biomechanical attributes of the pertinent tissue [11,12]. Collagen, serving as the principal structural protein constituent of the rotator cuff tendon, is instrumental in dictating the tendon's mechanical characteristics. Alterations to the collagen matrix that compromise its structural integrity may result in diminished strength and resilience of tendons, thereby increasing the risk of re-tear incidents. Concurrently, hyperglycemic conditions can lead to a reduction in proteoglycan content by disrupting the synthesis and sulfation of glycosaminoglycans. Proteoglycans are crucial for maintaining the structural integrity and lubricative properties of tendon tissue; hence, their decreased levels are positively correlated with a degradation in the mechanical properties of the tendon tissue. The observed decrement significantly impedes the healing and restoration mechanisms inherent to tendon tissue repair

This study is subject to intrinsic limitations, primarily stemming from its retrospective design, which has the potential to introduce bias into the results. The sample size for this investigation was restricted to 60 participants, which is relatively small and may affect the generalizability of the findings, thus limiting their ability to precisely reflect the attributes of the broader population. Furthermore, the criteria for identifying diabetic patients with poor glycemic control are somewhat subjective. The methods employed to assess the extent of chronic hyperglycemia in diabetic cohorts lack universally accepted standards.

5. Conclusion

Patients electing for surgical intervention who have diabetes must be informed of the increased risks related to the postoperative recovery process. Individuals with diabetic rotator cuff injuries should adhere to a routine monitoring protocol for their HbA1c levels in the preoperative period. Patients with suboptimal glycemic control must receive therapeutic intervention, encompassing rigorous dietary management, physical activity, and pharmacological measures, to attain consistent blood glucose levels prior to undergoing rotator cuff repair surgery. Throughout the postoperative recovery period, it is critical to closely monitor the patient's glycemic status and make timely adjustments to the treatment protocol to promote optimal convalescence. The need for improved health education is pronounced for diabetic individuals with rotator cuff injuries, mandating a personalized strategy to ensure the effectiveness of educational initiatives. The customization process must account for the unique attributes associated with disparate age cohorts and diverse educational pedigrees. The significance of maintaining optimal blood glucose levels in modulating the progression and determining the therapeutic outcomes of rotator cuff injuries must be underscored. Concurrently, there is a critical need to enhance patient competencies in the self-management of their blood glucose concentrations.

Subsequent inquiries are poised to gain significantly from improvements and broadening in several pivotal areas. Elevating the sample size is a crucial procedural step for bolstering the reliability of research findings. Enlarging the sample size allows for a more accurate depiction of the general population, concurrently reducing the margin of error that accompanies a smaller sample size. Refining the study design is essential; the adoption of a prospective study framework reduces the risks of selection bias that are inherent in retrospective methodologies, thereby improving the manipulation of study variables. The delineation of poor glycemic control requires a more rigorous and discerning scientific methodology, with the refinement of this definition achieved through the amalgamation of diverse biomarkers for a comprehensive evaluation. Enhancing the fidelity and accuracy of the dataset necessitates the meticulous refinement of the data collection process. This modification is anticipated to enable a more exhaustive evaluation of patient recovery at diverse temporal intervals. The proposed improvements and expansions are expected to enhance the understanding of the effects of glycemic control on outcomes in patients suffering from rotator cuff tears, thereby providing more stringent and effective recommendations for clinical therapeutic strategies.

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