

Evaluation of Hemoglobin A1c Three Months Before and After Arthroscopic Rotator Cuff Repair in Diabetic Patients

Abstract

Background: Recently, the relationship between clinical outcomes and postoperative complications in diabetic patients undergoing arthroscopic rotator cuff repair have been reported. However, very few studies have focused on the association between preoperative hemoglobin levels and postoperative complications. The aim of this study was to evaluate this association six months after surgery by the average level of hemoglobin A1c three months before and three months after surgery in diabetic patients.

Methods: This retrospective study was conducted on 61 patients with diabetes mellitus who had undergone arthroscopic rotator cuff repair between 2019 and 2021 in two teaching hospitals. The hemoglobin A1c (HbA1c) level three months before and 3 months after surgery were documented, and the complications such as infection, wound dehiscence, and postoperative stiffness, and need for revision surgery within 6 months post surgery were evaluated.

Results: Sixteen patients (26.2%) experienced stiffness after surgery. There was no case of wound dehiscence, tissue infection, or need for revision surgery within six months after the initial surgery. The results of multivariate logistic regression analysis showed that age (odds ratio - OR: 1.13, 95% confidence interval ;CI: 1.03, 1.27, p: 0.041), male gender (OR: 1.88, 95% CI: 1.11, 2.75, p: 0.001), and HbA1c levels before (OR: 1.23, 95% CI: 1.03, 1.48, p: 0.011) and after surgery (OR: 1.11, 95% CI: 1.02, 1.26, p: 0.023) were associated with higher risk of stiffness after surgery.

Conclusion: Our study showed that the mean pre-operative level of HbA1c and its post-operative value were significantly associated with an increased incidence of stiffness after arthroscopic rotator cuff repair surgery.

Keywords: Hb A1c, Rotator Cuff Injuries, Arthroscopy, Postoperative Complications

Accepted: 65 days before printing

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Introduction

Rotator cuff tear is a, relatively, common shoulder disorder, with prevalence ranging from 13% in patients under 50 years old to over 50% in patients over 80 years old^(1,2). Nearly two million patients annually seek medical care for rotator cuff injury, with two-thirds experiencing mild and transient symptoms, and one-third presenting with symptoms of pain, muscle weakness, and limited range of motion, necessitating surgical repair to restore function⁽³⁻⁵⁾. Arthroscopic rotator cuff repair (ARCR) is one of the most common orthopedic surgeries performed in United States⁽⁵⁾. It is considered a suitable and semi-conservative treatment option for these patients and is regarded as a safe and effective method for those with appropriate indications for surgery. However, like any surgical procedure, ARCR is not without complications, the most significant being infection, shoulder stiffness, and re-tear of the rotator cuff⁽⁶⁻⁸⁾.

Diabetes is one of the most common endocrine diseases, with its incidence increasing globally due to increased life expectancy and an aging population⁽⁹⁾. It is estimated that by 2030, the global prevalence of diabetes will rise to 10.2%⁽¹⁰⁾. Diabetes can exacerbate surgical complications, including infection, reduced tissue quality for repair, and slower wound healing. One controllable factor in

these patients is the proper management of glycemic indices before surgery, which appears to have a protective role in at least reducing the incidence of postoperative infections^(11,12). Additionally, persistent hyperglycemia in diabetic patients can lead to repair failure of the rotator cuff⁽¹³⁾.

HbA1c, which is a serological marker indicating average blood glucose level over a time period, has become an essential tool in diagnosing and managing diabetes⁽¹⁴⁾. Studies have shown that high HbA1c levels are associated with an increased incidence of complications and adverse outcomes in various conditions⁽¹⁴⁾. The relationship between diabetes and postoperative complications following arthroscopic rotator cuff repair has been reported in several studies^(6,15-18). Previous studies have primarily examined the correlation between preoperative HbA1c levels and postoperative complications and clinical outcomes^(16,17). To the best of our knowledge, no study has previously investigated the relationship between the HbA1c levels three months before and three months after surgery in relation with the complications that may manifest six months post arthroscopic rotator cuff repair.

Materials and Methods

This retrospective analytical study was conducted, (after obtaining approval from the Ethics Committee of Iran University of Medical Sciences - code: IR.IUMS.FMD.REC.1399.245) between 2019 and 2021 at Rasul Akram and Moheb Mehr hospitals in Tehran, Iran. After applying the inclusion criteria, 61 diabetic patients who had undergone arthroscopic rotator cuff repair were included in the study. Patient sampling was performed conveniently from those who met the study criteria. Diabetes was defined based on the American Diabetes Association's 2018 criteria⁽¹⁹⁾, where individuals with a 2-hour plasma glucose from OGTT ≥ 200 mg/dL, and/or HbA1c $\geq 6.5\%$, and/or FPG ≥ 126 mg/dL were considered diabetic⁽¹⁹⁾.

Inclusion criteria included a confirmed diagnosis of type-2 diabetes based on laboratory findings and internal medicine specialist diagnosis, patients aged 18 to 80 years, those who underwent arthroscopic rotator cuff repair, patients with a normal range of motion in the healthy shoulder, complete patient record information, and cooperation for follow-up of

possible complications. Exclusion criteria included underlying infectious diseases, history or presence of open or complex shoulder surgeries, history or presence of shoulder infections, neurological diseases (e.g., Parkinson's, MS) affecting shoulder movements, history of cervical spine surgery, history of surgery on the opposite shoulder, complaints of pain in the healthy shoulder, history of frozen shoulder in the opposite shoulder, and patient unwilling or unhappy to continue participating in the study.

Routine surgery was performed for the patients, and the researcher followed up with them to record postoperative complications without any intervention. The patient's information was extracted from the hospital's medical records using a two-part checklist which included demographic information (age, gender, body mass index, comorbidities, and smoking status) and laboratory data (HbA1c levels). HbA1c was assessed and recorded for all the patients three months before and three months after surgery. All the patients were followed up for six months postoperatively for tissue infections, the need for re-surgery, wound dehiscence, and postoperative stiffness. The presence of at least one of the following three criteria was defined as postoperative stiffness⁽²⁰⁾:

- Forward elevation $< 120^\circ$
- External rotation with the arm at the side $< 30^\circ$
- Internal rotation behind the back lower than L3

The relationship between those two times HbA1c levels and complications within six-month was evaluated.

Sample Size

The appropriate sample size for this study was determined based on an estimated correlation coefficient of 0.383 between HbA1c and postoperative complications following arthroscopic rotator cuff repair, as per Hwang et al.⁽²¹⁾. With this in mind, considering a 5% error and 80% power using G power software version 3.1 and accounting for a 15% dropout rate, 59 patients were required. Consequently, 61 patients were included in the study.

Statistical Analysis

SPSS software version 22 was used for statistical analysis. To describe the data, mean and standard

deviation were used for quantitative variables, and frequency and percentage for qualitative variables. Pearson's correlation coefficient was employed to assess the correlation between quantitative variables. The paired t-test was used to compare pre- and post-operative HbA1c changes, assuming normal distribution. If the normality assumption was violated, the Wilcoxon test was used. Multivariate logistic regression analysis was used to control for confounding variables. All variables with a p-value less than 0.15 in univariate analysis were entered into the multivariate logistic regression analysis using the forward approach. The association between variables was estimated using odds ratios with a 95% confidence interval. A p-value of less than 0.05 was considered statistically significant.

Results

In total, 61 patients were included in the study. The mean age of the patients was 55.2 ± 5.9 years (range 40 to 80 years), with 36 (59%) being female. The mean body mass index (BMI) was 26.11 ± 3.22 kg/m². 21 (36.1%) patients had at least one comorbid condition other than diabetes, with hypertension being the most common. Most patients had a high school diploma. (14.8%) of the patients were smokers. Demographic information of the patients is presented in Table 1.

Mean HbA1c 3 Months Before and 3 Months After Surgery

Nine (14.8%) of the patients were smokers. Overall, the mean HbA1c of the study participants was 7.3 ± 1.09 mmol/mol three months before and 6.8 ± 0.8 mmol/mol six months after surgery. This difference was statistically significant ($p: 0.02$).

Post-Operative Complication Rates

The only observed complication was post-operative shoulder stiffness observed in 16 (26.2 %) (Table 2).

Analysis of the Association Between Post-Operative Stiffness and Mean HbA1c and Other Clinical Variables

Univariate analysis results showed that higher mean HbA1c, whether before or after surgery, was associated with higher post-operative stiffness

Table 1: Distribution of Demographic Characteristics of 61 Diabetic Patients Undergoing Arthroscopic Rotator Cuff Repair Surgery

Variable		Number (%)
Gender	Male	25 (41%)
	Female	36 (59%)
Education Level	Illiterate	5 (8.2%)
	Less than Diploma	18 (29.5%)
	Diploma	30 (49.2%)
	Higher than Diploma	8 (13.1%)
Presence of Other Underlying Diseases	None	40 (66.6%)
	Hypertension	17 (27.9%)
	Heart Diseases	1 (1.6%)
	Others	3 (4.9%)
Smoking Status	Yes	9 (14.8%)
	No	52 (85.2%)
Age, Mean \pm SD*, (years)		55.2 \pm 5.9
Body Mass Index, Mean \pm SD, (kg/m ²)		26.11 \pm 3.22
Follow-up Duration, Mean \pm SD, (months)		7.55 \pm 2.11

* SD: Standard Deviation

Table 2: Complications of 61 Diabetic Patients Undergoing Arthroscopic Rotator Cuff Repair Surgery

Complications		Number (%)
Tissue Infection	Yes	0 (0%)
	No	61 (100%)
Wound Dehiscence	Yes	0 (0%)
	No	61 (100%)
Need for Reoperation	Yes	0 (0%)
	No	61 (100%)
Post-operative Stiffness	Yes	16 (26.2%)
	No	45 (73.8%)

($p < 0.05$). Additionally, the incidence of post-operative stiffness was higher in older patients ($p: 0.011$) and also in males ($p: 0.001$). The incidence of post-operative stiffness was also significantly higher in patients with underlying diseases ($p: 0.044$). No significant association was found with other background variables ($p > 0.05$). (Table 3).

Table 3: Comparing relation between demographic variables with stiffness of tissue after arthroscopic surgery

Variables		Incidence of Post-operative Stiffness		p-value
		Yes (16)	No (45)	
Age (Mean ± Standard Deviation, years)		60.06 ± 3.73	53.55 ± 5.71	0.011
Gender	Male	9 (56.3%)	16 (35.6%)	0.001
	Female	7 (43.8%)	29 (64.4%)	
Education Level	Illiterate	1 (6.3%)	1 (6.3%)	0.907
	Less than Diploma	4 (25%)	4 (25%)	
	Diploma	8 (50%)	8 (50%)	
	Higher than Diploma	3 (18.7%)	3 (18.7%)	
Presence of Other Underlying Diseases	None	9 (56.2%)	31 (68.9%)	0.044
	Hypertension	6 (37.5%)	11 (24.5%)	
	Heart Diseases	0 (0%)	1 (2.2%)	
	Others	1 (6.3%)	2 (4.4%)	
Smoking Status	Yes	2 (12.6%)	4 (8.9%)	0.098
	No	13 (87.4%)	39 (91.1%)	
Mean Body Mass Index (kg/m ²)		27.22 ± 3.21	25.88 ± 3.55	0.043
Mean HbA1c Before Surgery (mmol/mol)		7.99 ± 1.066	6.95 ± 0.99	0.028
Mean HbA1c After Surgery (mmol/mol)		7.11 ± 0.94	6.62 ± 0.86	0.001

Table 4: Results of Multivariate Analysis

Variable	Odds Ratio	95% Confidence Interval		p-value
		Lower Limit	Upper Limit	
Mean HbA1c Before Surgery (mmol/mol)	1.11	1.26	1.02	0.023
Mean HbA1c After Surgery (mmol/mol)	1.23	1.48	1.03	0.011
Gender (Male)	1.88	2.75	1.11	0.011

Multivariate Logistic Regression Analysis

Results from multivariate logistic regression analysis showed that the likelihood of post-operative stiffness was significantly associated with older age (odds ratio: 1.13, 95% confidence interval: 1.03-1.27, p: 0.041), male gender (odds ratio: 1.88, 95% confidence interval: 1.11-2.75, p: 0.001), and higher mean HbA1c after surgery (odds ratio: 1.23, 95% confidence interval: 1.03-1.48, p: 0.011) and before

surgery (odds ratio: 1.11, 95% confidence interval: 1.02-1.26, p: 0.023). (Table 4)

Discussion

Several studies have shown a correlation between high HbA1c levels and increased postoperative complications following arthroscopic rotator cuff repair^(6,15-18). Given the high prevalence of diabetes in the population and the increasing life expectancy,

examining the role of HbA1c levels before and after surgery on surgical complications is crucial.

Our study results showed that the mean age of patients was 55.2 years, with the majority in their fourth and fifth decades of life. Most patients were female, likely due to the higher prevalence of rotator cuff tears in women. The BMI of most patients was normal, ranging from 20 to 25. Over one-third of the patients had at least one other underlying condition besides diabetes, with hypertension being the most common. The mean HbA1c levels before and after surgery were 7.3 and 6.8 mmol/mol, respectively. Postoperative complications were reported in 16 (26.2%) patients, all of whom experienced shoulder stiffness. No other serious complications, such as infections, the need for reoperation, or wound dehiscence, were observed in the six months post operative assessment. These findings coincides with findings of Takahashi and colleagues who reported no infection following arthroscopic rotator cuff repair in their 2022 study⁽¹⁷⁾.

Univariate analysis results indicated that higher mean HbA1c levels before and after surgery were significantly associated with an increased incidence of postoperative stiffness. Additionally, the incidence of postoperative stiffness was significantly related to patients' age, gender, and the presence of concomitant underlying diseases. After adjusting for demographic and clinical variables, logistic regression analysis showed that the likelihood of postoperative stiffness remained significantly associated with older age, male gender, and higher mean HbA1c levels before and after surgery. Each unit increase in mean HbA1c before and after surgery increased the likelihood of postoperative stiffness by 0.11 and 0.23, respectively. The likelihood of postoperative stiffness was nearly twice as high in men compared to women, and increased age was associated with a higher probability of postoperative stiffness. These results are consistent with previous studies^(22,23).

In a study by Z Borton and colleagues in 2020, postoperative complications following arthroscopic shoulder surgery were examined in 462 patients over four years. While our study focused solely on diabetic patients, their study showed that diabetic patients were nearly twice as likely to experience complications after rotator cuff repair via arthroscopy. They also reported a twofold risk of treatment failure and a fourfold risk of frozen

shoulder in these patients. Another study by JM Canciones et al. in 2019 examined the relationship between intraoperative HbA1c control and complications and adverse outcomes six months after arthroscopic rotator cuff repair in 3740 patients. They found that the risk of complications and infections in diabetic patients increased with higher postoperative HbA1c levels, which supports our study's findings. In our study, higher HbA1c levels before and after surgery were associated with an increased likelihood of postoperative stiffness. Similarly, in a study by MS Kim et al. in 2022, evaluating the association between HbA1c control and postoperative complications and outcomes in 103 diabetic patients using multivariate logistic regression analysis, mean HbA1c levels were identified as an independent risk factor for postoperative complications, aligning with our study's results. Furthermore, a 2020 review by L Yang and colleagues⁽²⁴⁾ comparing clinical outcomes and complications after rotator cuff repair in diabetic and non-diabetic patients showed that diabetes was significantly associated with increased postoperative complications.

Overall, our study had strengths and weaknesses that need to be addressed. The main limitation was the use of patient records, which could not account for many influential variables, such as retear rates. Another limitation was the lack of a control group (non-diabetic patients) for comparison of postoperative complications following arthroscopic rotator cuff repair. Future prospective studies with control groups could provide more accurate results. The main strength of our study was the assessment of postoperative complications in a suitable sample size of diabetic patients and the evaluation of the association between complications and background variables and HbA1c levels using multivariate logistic regression analysis.

Conclusion

Based on our study results, the mean HbA1c levels before and after surgery were identified as independent risk factors for increasing the likelihood of postoperative stiffness following arthroscopic rotator cuff repair. Controlling HbA1c levels before and after surgery may help reduce postoperative complications, especially in diabetic patients, particularly in men over 50 years of age.

Acknowledgements

The authors thank all participants in this study and the Vice-Chancellor for Research of the School of Medicine, Iran University of Medical Sciences, for their cooperation in conducting this study.

Conflict of Interest

The authors declare no conflict of interest in this study.

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