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ORIGINAL ARTICLE

Effect of Smoking on Postoperative Function and Quality of Life After Full Thickness Arthroscopic Rotator Cuff Repair: A Retrospective Analysis

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Abstract

Purpose The effect of smoking on preoperative and postoperative outcome scores as well as quality of life measurements after arthroscopic rotator cuff repair (ARCR) has not been fully understood, and studies regarding this are lacking in the literature. This study aimed to evaluate the effect of smoking on function and quality of life after ARCR.

Methods Two-hundred patients who underwent full-thickness ARCR with a minimum 1-year follow-up period were included and evaluated retrospectively. The patients were divided into two groups: smokers (Group 1, 59 patients) and nonsmokers (Group 2, 141 patients). Pre- and postoperative Constant Murley (CM) scores, American Shoulder and Elbow Surgeons (ASES) scores, visual analogue scale scores (VASs), and Short-Form 36 health survey (SF-36) scores were used to evaluate functional and quality of life outcomes. The correlation between the smoking amount (pack-years) and outcomes was evaluated.

Results A total of 200 patients included into study (90 male and 110 female) with mean age of 62.68 ± 3.98. There was no statistically significant difference between the two groups regarding preoperative scores, except in the ASES score ($P = 0.021$) Additionally, there was a statistically significant difference between the groups regarding postoperative CM score, ASES score, and VAS, and in physical functioning and role limitations due to physical health domains of the SF-36 ($P = 0.029$, $P = 0.038$, $P = 0.021$ and $P = 0.020$, respectively). There were small to moderate negative correlations between amount of smoking and preoperative physical functioning, role limitations from emotional problems, energy/fatigue, emotional well-being, and pain domains of the SF-36. However, there were moderate to strong negative correlations between amount of smoking and postoperative SF-36 domains.

Conclusion Preoperative and postoperative functional outcome scores, and quality of life measurements are negatively affected from smoking. As the amount of smoking increases, postoperative results are negatively affected.

Level of evidence 3.

Keywords Smoking · Rotator cuff · Effect · Quality of life

Introduction

The incidence of rotator cuff tears has increased significantly due to aging population and increasing sports activities [1]. Arthroscopic rotator cuff repair, which is a widely accepted treatment for full thickness rotator cuff tears, is increasingly performed [2, 3]. Studies evaluating the factors associated with recovery and failure after rotator cuff repair have been identified with various risk factors related to the patient, such as age, preoperative tear size, fatty infiltration, osteoporosis and tendon quality [4–6]. Presence of a metabolic problems may be associated with rotator cuff re-tearing due to bone and tendon quality and circulation [7]. Various

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metabolic diseases such as diabetes mellitus and hypercholesterolemia have been studied for this purpose and have been reported to be associated with healing failure [8]. One of the well-known metabolic risk factors is smoking [9]. Smoking has been associated with the prevalence of rotator cuff tears, shoulder dysfunction, risk of rotator cuff tears, and greater size of rotator cuff tears [10, 11]. But, these harmful effects of smoking can affect recovery after rotator cuff repair through impaired muscle and tendon quality [12–15]. After arthroscopic rotator cuff repair, the effect of smoking on patient results is not fully understood [16]. The aim of this study was to evaluate the effect of smoking on arthroscopic rotator cuff repair functional outcomes as well as quality of life of patients.

Methods

This study was a retrospective study including prospectively collected data of patients from two hospitals. The records of 388 patients who underwent arthroscopic rotator cuff repair between 2017 and 2019 with a minimum 1-year follow-up period were evaluated.

Inclusion Criteria were (1) patients between 18 and 65 years old, (2) full thickness acute or chronic superior rotator cuff rupture, (3) patients who have not responded to conservative treatment for 3 months, and at least 1 year has passed since surgery, (4) Goutallier grade 0, 1 or 2 fatty degeneration, (5) Small to large sized (< 5 cm) tear.

Exclusion Criteria were (1) partial rotator cuff rupture, (2) massive cuff rupture, (3) open rotator cuff repair, (4) arthritic changes in the shoulder joint, (5) having other chronic shoulder problems, (6) history of surgery from the same shoulder, (7) subscapularis tear, (8) preoperative frozen shoulder, (9) lost to follow-up, (10) history of fracture around shoulder. After exclusions, 200 patients (59 patients in group 1 and 141 patients in group 2) were included.

The patients participating in the study were questioned whether they smoke, how long they have been smoking, and how many cigarettes smoking per day. The patients were divided into two groups. Group 1 patients were classified as smokers and Group 2 patients were classified as non-smokers.

All patients were operated by two experienced surgeons under general anesthesia in beach chair position. Biceps tenotomy was performed in all patients with biceps tendon pathology. Rotator cuff repair was performed using Smith and Nephew (London, UK) TWINFIX® suture anchor with an ULTRABRAID® suture or a FOOTPRINT PK® suture anchor. Single or double row repair was performed according to tear size.

The arm was immobilized at neutral position with a shoulder sling for 6 weeks. Passive mobilization was started and continued during the first 6 weeks and followed by progressive active mobilization. Strengthening exercises were started after postoperative 3 months.

Data were collected for both patient groups including age, gender, affected side, dominant side, symptom duration, body mass index (BMI), etiology (Acute/Chronic), follow-up time and tear size. The smokers were asked how many packs of cigarettes they were smoking daily, and the packet/year was calculated. For packet year calculation, the average of number of cigarettes smoked per day was divided by 20 to give packs per day and multiplied by the total number of years of smoking. The classification of full-thickness cuff rupture was performed by looking at the MRI results in radiological evaluation. In the classification made according to DeOrio and Cofield classification [17], the size of full-thickness tears of 1 cm small, 1–3 cm medium, 3–5 cm large and more than 5 cm was evaluated as massive. Constant Murley score (CM), American Shoulder and Elbow Surgeons Score (ASES), Visual analog score (VAS) and The Short-Form Health Survey (SF-36) scores were used in the evaluation of functional outcome and quality of life measurement.

Postoperative shoulder stiffness and pseudopesis development were evaluated by physical examination. Shoulder stiffness was defined as 'restriction of both active and passive shoulder range of motion in all directions with or without variability of the restriction degree at the different directions.

Re-rupture was evaluated using the presence of persistent pain, loss of strength and the development of acute pseudoparesis, and MRI evaluation (In the presence of complaints and physical examination findings) at the 6-month follow-up visit.

Preoperative and postoperative functional results and QoL scores were compared between the two groups. The relation between the amount of smoking and results were evaluated as well. Also, the frequency of postoperative complication rates was compared.

The study protocol was approved by Uludag University clinical investigations research ethics board (Approval date and number: 08.07.2020/2020-12/12). An informed consent was obtained from all patients.

Mean, median, frequencies, minimum, maximum and standard deviation (SD) measures were used for descriptive statistics. The Shapiro–Wilk test was used for the evaluation of the distribution of variables.

Independent samples *t* test and Mann Whitney *U* tests were used in the comparison of quantitative independent data. Paired samples *t* test and Wilcoxon signed rank test were used in the comparison of quantitative dependent data. Chi-square or Fischer exact tests were used in the comparison of qualitative data. Pearson and Spearman correlation tests were used in the assessment of correlations between

amount of smoking and functional and quality of life measures. Correlation coefficient (r) more than 0.7 was defined as strong, between 0.5 and 0.7 as moderate, between 0.3 and 0.7 as fair and less than 0.3 as no correlation between two values. A P value < 0.05 was considered statistically significant. All statistical analysis was performed using IBM SPSS for Windows, version 22 (IBM corp., Armonk, NY).

Results

The mean age of patients was 62.68 ± 3.98. The mean follow-up period was 19.10 ± 3.52 months. There was no significant difference between smokers and non-smokers regarding patient characteristics (Table 1).

There was no statistically significant difference between two groups regarding preoperative CM and VAS, and SF-36 scores (P >0.05). However, there was a statistically significant difference in preoperative ASES score (P < 0.05). In addition, there was a statistically significant difference between two groups regarding the postoperative CM, ASES, VAS, and physical functioning and role limitations due to physical health domains of SF-36 (P < 0.05) (Table 2).

When the postoperative CM, ASES, VAS scores of both groups were evaluated, there was a statistically significant difference in favor of Group 2 in the CM, ASES and VAS scores (P < 0.05).

There was small to moderate negative correlations between the amount of smoking and the preoperative physical functioning, role limitations due to emotional problems, energy / fatigue, emotional well-being and pain domains of SF-36. However, there was moderate to severe negative correlations between the amount of smoking and the postoperative all SF-36 domains (Table 3).

There was no significant difference between smokers and non-smokers regarding the re-rupture. However, there was a significantly higher stiff shoulder development in smoker group (Table 4). The amount of smoking had strong correlation with tear size and the development of stiff shoulder and re-rupture (P = 0.003, r = 0.634; P < 0.001, r = 0.721; and P < 0.001, r = 0.798, respectively). However, there was no significant correlation between the amount of smoking and the metabolic diseases that patients had.

Discussion

The main findings of this study were that smoking was associated with inferior preoperative ASES and postoperative CM, ASES, VAS scores, and physical functioning and role limitations due to physical health domains of SF-36 score. The amount of smoking was found to be associated with tear size, re-rupture and stiffness development.

Park et al. [18] reported that, only larger retraction and heavy smoking history as independent prognostic factors were associated with cuff healing failure. Mallon et al. [19] reported that smoking had a negative effect on the clinical outcome in terms of pain and UCLA score after rotator cuff repair. Balyk et al. [20] found that smoking in rotator cuff repairs is an independent predictor of low ASES and WORC scores. Baumgarten et al. [21] reported that the outcome scores reported by the patient before and after surgery were worse for smokers than non-smokers. Contrary to these results, McElvany et al. [22] reported that studies with a higher percentage of smokers in meta-analyses yielded more positive results. In the systematic review of Raman et al. [4], the history of smoking before surgery had no significant effect on the results after rotator cuff repair. Prasad et al. [23] could not statistically demonstrate a significant correlation

Table 1 Patient characteristics in smoker and non-smoker groups

Variables	Group 1 n = 59 (Mean ± SD)/N (%)	Group 2 N = 141 (Mean ± SD)/N (%)	P value
Age (years)	56.83 ± 4.63	65.13 ± 5.19	0.665
Sex (male/female)	23/36 (39%/61%)	67/74 (47.5%/52.5%)	0.269
Dominant side (right/left)	32/27 (54.2%/45.8%)	84/57 (59.6%/40.4%)	0.486
Follow-up period (months)	19.33 ± 4.20	19.01 ± 3.03	0.640
Affected side (right/left)	27/32 (45.8%/54.2%)	74/67 (52.5%/47.5%)	0.386
Symptom duration (months)	6.14 ± 2.53	6.15 ± 2.39	0.633
BMI (kg/m^2)	27.98 ± 2.72	27.41 ± 2.46	0.487
Acute/chronic	13/46 (22%/78%)	20/121 (14.2%/85.8%)	0.173
Size			
Small	11 (%18.64)	42 (%29.78)	0.068
Medium	39 (%66.10)	68 (%48.22)	
Large	9 (%15.25)	31 (%21.98)	

Table 2 Pre-and post-operative CM, ASES, VAS and SF-36 scores in Group 1 and 2

	Group 1 ($n=59$) (Mean ± SD)	Group 2 ($n=141$) (Mean ± SD)	p
Constant Murley Score			
Pre-op	41.05 ± 5.32	41.67 ± 5.53	0.268
Post-op	74.86 ± 12.61	78.45 ± 10.64	**0.029**
p	**< 0.001**	**< 0.001**	
ASES			
Pre-op	41.02 ± 7.22	42.94 ± 6.77	**0.021**
Post-op	75.24 ± 12.91	78.92 ± 10.67	**0.038**
p	**< 0.001**	**< 0.001**	
VAS			
Pre-op	6.17 ± 0.77	6.20 ± 0.88	0.928
Post-op	2.37 ± 1.53	1.89 ± 1.30	**0.021**
p	**< 0.001**	**< 0.001**	
Physical functioning			
Pre-op	60.25 ± 9.84	59.33 ± 7.82	0.920
Post-op	83.37 ± 8.77	87.79 ± 11.06	**0.033**
p	**< 0.001**	**< 0.001**	
Role limitations due to physical health			
Pre-op	19.15 ± 19.47	18.97 ± 15.78	0.679
Post-op	73.39 ± 15.01	78.23 ± 15.13	**0.020**
p	**< 0.001**	**< 0.001**	
Role limitations due to emotional problems			
Pre-op	40.34 ± 25.47	40.33 ± 27.80	0.986
Post-op	87.36 ± 17.67	86.29 ± 18.95	0.742
p	**0.003**	**< 0.001**	
Energy/fatigue			
Pre-op	28.47 ± 11.68	30.92 ± 10.68	0.194
Post-op	77.37 ± 12.46	74.57 ± 14.36	0.200
p	**< 0.001**	**< 0.001**	
Emotional well-being			
Pre-op	35.53 ± 10.45	33.05 ± 12.22	0.178
Post-op	66.75 ± 18.22	70.71 ± 13.27	0.472
p	**< 0.001**	**< 0.001**	
Social functioning			
Pre-op	27.22 ± 11.85	28.95 ± 9.44	0.333
Post-op	73.73 ± 11.05	72.70 ± 13.64	0.575
p	**< 0.001**	**< 0.001**	
Pain			
Pre-op	24.63 ± 9.10	22.87 ± 9.96	0.532
Post-op	79.80 ± 14.97	73.29 ± 21.58	0.102
p	**< 0.001**	**< 0.001**	
General health			
Pre-op	28.90 ± 13.80	28.72 ± 12.76	0.438
Post-op	78.90 ± 12.10	75.35 ± 16.56	0.784
p	**< 0.001**	**< 0.001**	
Health change			
Pre-op	21.61 ± 17.65	19.15 ± 15.13	0.408
Post-op	86.02 ± 14.87	78.37 ± 18.71	**0.009**
p	**< 0.001**	**< 0.001**	

Bold values indicate statistical significance

Table 3 The correlation table between amount of smoking and CM, ASES, VAS And SF-36 scores

	Packet Year Correlation	
	r	p
Constant Murley score		
Preoperative	−0.386**	0.003
Postoperative	−0.859**	0.000
ASES score		
Preoperative	−0.573**	0.000
Postoperative	−0.879**	0.000
VAS		
Preoperative	0.164	0.215
Postoperative	0.844**	0.000
Physical functioning		
Preoperative	−0.398**	0.002
Postoperative	−0.726**	0.000
Role limitations due to physical health		
Preoperative	0.151	0.253
Postoperative	−0.533**	0.000
Role limitations due to emotional problems		
Preoperative	−0.286*	0.028
Postoperative	−0.568**	0.000
Energy/fatigue		
Preoperative	−0.338**	0.009
Postoperative	−0.717**	0.000
Emotional well-being		
Preoperative	−0.434**	0.001
Postoperative	−0.574**	0.000
Social functioning		
Preoperative	−0.144	0.275
Postoperative	−0.606**	0.000
Pain		
Preoperative	−0.447**	0.000
Postoperative	−0.637**	0.000
General health		
Preoperative	−0.210	0.110
Postoperative	−0.656**	0.000
Health change		
Preoperative	−0.007	0.959
Postoperative	−0.796**	0.000

ASES: The American shoulder and elbow surgeons, VAS: Visual analog scale

Table 4 Postoperative shoulder stiffness and re-rupture rates in smoker and non-smoker groups

	Group 1 *N* (%)	Group 2 *N* (%)	Total *N* (%)	*p*
Shoulder stiffness				
+	8 (13.6)	6 (4.3)	14 (7.0)	0.019
–	51 (86.4)	135 (95.7)	186 (93)	
Re-rupture				
+	4 (6.8)	9 (6.4)	13 (6.5)	0.917
–	55 (93.2)	132 (93.6)	187 (93.5)	

of smoking with either CMS for clinical evaluation or VAS scores to chart pain. Naimark et al. [12] found that smoking was less likely to improve with ASES score in their mean 2-year follow-up, but not WORC or VAS pain scores. Lambers et al. [24] concluded that there was insufficient evidence that smoking was not effective on functional results. In our study, when the preoperative and postoperative CM, ASES and VAS scores of Group 1 and 2 were evaluated within themselves, there was a statistically significant difference in terms of recovery ($P < 0.05$). When the preoperative CM, ASES, VAS scores of both groups were evaluated, there was no statistically significant difference in CM and VAS scores ($P > 0.05$), but there was a statistically significant difference in favor of Group 2 in the ASES score ($P < 0.05$). When the postoperative CM, ASES, VAS scores of both groups were evaluated, there was a statistically significant difference in favor of Group 2 in CM, ASES and VAS scores ($P < 0.05$). In our study, clinical postoperative scores were significant in favor of Group 2. This result is compatible with many studies in the literature.

Baumgarten et al. [21] found a dose-related relationship between smoking and the outcome scores determined by the patient before and after surgery. Particularly, high dose smokers had significantly lower WORC and ASES scores before and after surgery and significantly lower postoperative SST scores in the postoperative period compared to the non-smoker group. In contrast, there is a study showing that smoking status has a negative effect on patients with RTC tendon rupture [25]. Our study showed that, as the package year increased, there was a significant moderate negative correlation in preoperative CM and ASES scores and no significant change in the VAS score.

Some authors reported that smokers tend to have larger rotator cuff tears than non-smokers, while others [10, 14, 15, 26], could not find a relationship between cigarette and size of the tears [1, 21, 26].

In our study, the tear size distributions of both groups were not statistically significant. The rupture etiology and symptom duration distributions of the patients in our study were not statistically significant. Therefore, a significant relationship could not be established between cigarette and rupture size ($P > 0.05$). However, pack-years were significantly higher in the group with a large tear in smoking patients ($P < 0.05$).

There are publications in the literature that cigarettes form less maturing collagen at the surgical wound site, increase the degenerative feature of the rotator cuff, cause poor tendon quality, and negatively affect rotator cuff healing [11, 14, 15, 27, 28].

Randelli et al. [29] reported that, smoking was associated with higher re-rupture rates in small and medium size cuff tears, but not in large and massive tears. Heyer et al. [30] showed in their study that smoking is not associated with an increased risk of complications following ARCR. In our study, symptomatic retear rates were similar between smoker and non-smokers but postoperative stiffness rate were significantly higher in smokers.

Smoking is closely related to metabolic diseases such as diabetes mellitus and hypercholesterolemia [31]. Metabolic conditions have been shown to be associated with a higher healing failure rate, it is possible that the smoker may deteriorate healing by intensifying these metabolic conditions after rotator cuff repair [32, 33].

In our study, there was no statistically significant difference between the distribution of metabolic diseases among patients in the smoker and non-smoker groups. When both groups were compared, shoulder stiffness was statistically significant in favor of Group 1 ($P < 0.05$). When evaluated for re-rupture, no statistically significant difference was found for the two groups ($P > 0.05$). Based on our findings, we may conclude that the difference between the two groups was based on smoking status rather than any other concomitant metabolic disease.

In the literature, only a few population studies have examined the relationship between smoking and SF-36 [34]. In some studies, no difference was found between smokers and non-smokers in any of the SF-36 subscales [35]. Woolf et al. [36] reported that current smokers have lower SF-36 scores for vitality, social health, emotional role function and mental health. Laaksonen et al. [34] found the only difference between the old smokers and no-smokers in the subscale of somatic pain. We did not find any study on smoking and SF-36 in patients undergoing arthroscopic rotator cuff surgery. When the preoperative and postoperative SF-36 scores of both groups were evaluated within themselves, there was a significant difference regarding statistical improvement in all subgroups. In the preoperative SF-36 score evaluation of groups 1 and 2, there was no statistically significant difference between all subgroups ($P > 0.05$). In the postoperative SF-36 score evaluation of group 1 and 2, there was a statistically significant difference in favor of group 2 in physical functioning and role limitations due to physical health subgroups ($P < 0.05$). There was no statistically significant difference between the remaining SF-36 subgroups ($P > 0.05$).

Increasing package year in the evaluation of preoperative quality of life; physical functioning, role limitations due to emotional problems, energy/fatigue, emotional well-being and pain scores showed small and moderate negative correlations, but no significant correlation was observed in the remaining subgroups. In all postoperative SF-36 scores, we found moderate and severe negative correlations with package year increase.

The strengths of this study were that we included relatively high number of patients which allowed us to evaluate both functional and QoL measurement scores adequately. Also, we did not simply divide the patients as smokers and non-smokers, we also evaluated the effect of amount smoking on both preoperative and postoperative functional results and QoL scores as well.

This study has some limitations. First, it was a retrospective study. Second, the number of smokers was relatively low when compared to nonsmokers. Third, MRI was used in the evaluation of the tendon integrity. Finally, the mean follow-up period was relatively short. The outcomes might be different in the longer follow-up period.

Conclusion

In conclusion, preoperative and postoperative functional outcome scores, and quality of life measurements are negatively affected from smoking. As the amount of smoking increases, postoperative results are negatively affected. Future prospective studies should be designed to obtain stronger evidences about the effect of smoking on outcomes before and after rotator cuff repair.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standard statement This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed consent For this type of study informed consent is not required.

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