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Predictors of allocation to surgery in patients older than 50 years with partial-thickness rotator cuff tear

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Background: The purpose of this study was to determine the predictive factors for allocation to surgery in patients older than 50 years with symptomatic chronic partial-thickness rotator cuff tear (PTRCT).
Methods: Patients older than 50 years with a confirmed diagnosis of unilateral isolated PTRCT were included in this retrospective study. In the minimum follow-up of 2 years, eventual allocation to surgical or nonsurgical treatment was determined individually. Patients who underwent surgery were defined as failed conservative management and allocation to surgery. Data pertaining to patients' demographics, functional comorbidity index values, duration of symptoms, and American Shoulder and Elbow Surgeons scores were collected from our medical records. Tear side and Ellman classification, subacromial spur, and acromiohumeral intervals were also noted. A regression analysis was performed to determine the major predictors of allocation to surgery.
Results: There were 202 patients with a mean age of 62 years in group I (no-surgery group) and 70 patients with a mean age of 57 years in group II (surgery group). The mean age and functional comorbidity index values were significantly higher in group I than in group II ($P < .001$ and $P < .001$, respectively). Bursal-sided tears were significantly more common in group II ($P = .026$). According to the findings of regression analysis, tear side and functional comorbidity index were the major predictors of allocation to surgery ($P = .015$ and $P < .001$, respectively).
Conclusion: Our study results indicate that in patients older than 50 years with PTRCTs, those with fewer comorbidities and bursal-sided PTRCTs were significantly more likely to undergo surgery.
Level of evidence: Level II; Retrospective Design; Prognosis Study

Keywords: Partial-thickness rotator cuff tear; nonoperative treatment; surgery; treatment allocation; comorbidity; predictors of surgery

This study was approved by the Ethical Committee of Erzincan University Faculty of Medicine (ID: 33216249-604.01.02-E.23593).

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Partial-thickness rotator cuff tear (PTRCT) is one of the most common shoulder disorders in adults that can cause persistent pain and loss of function.[12] Initial management, including drug therapy, activity modification, physical therapy, and intra-articular injections, is mostly successful.[10] Surgical treatment is generally recommended for PTRCTs when the tear extends to >50% of the tendon or when patients experience persistent pain and disability that are not relieved by conservative treatment modalities. In addition, acute traumatic tears and tears in physically active young patients are relative indications for surgical treatment.[4] However, current evidence does not provide guidance as to the best management of PTRCTs.[5] Hence, it is difficult for orthopedic surgeons to manage the treatment and to predict the natural course of the disease.

PTRCT must be evaluated separately in older and younger patients in terms of differences in healing potential, cause of the tear, levels of activity and physical demands, and long-term expectations.[9] Besides, the extent of tear was reported to be greater in older patients than in younger ones.[11] It is important for clinicians to identify the potential candidates for future surgical intervention among the elderly population with symptomatic PTRCT who mostly present with chronic shoulder pain at admission in daily practice. Previously, Dunn et al[2] and Kweon et al[8] identified the predictive factors for undergoing surgery in patients with full-thickness rotator cuff tears. However, we could not find any study in the literature evaluating the predictors of undergoing surgery for patients with PTRCT.

In this study, we aimed to determine the predictive factors for undergoing surgery during follow-up of patients older than 50 years with symptomatic chronic PTRCT, the population with the highest prevalence of PTRCT. We hypothesized that patients' characteristics such as age, sex, and comorbidities are better associated with response to conservative management and allocation to surgery than are characteristics such as tear size and functional score.

Methods

Selection of patients

This is a retrospective case-control study that evaluated the predictors of allocation to surgery in patients older than 50 years with PTRCT. Data of patients who were referred to our clinic between January 2015 and January 2016 and diagnosed with PTRCT were collected from our medical records. Patients diagnosed with unilateral isolated partial-thickness supraspinatus tear, which was confirmed by magnetic resonance imaging (MRI), were included. The exclusion criteria were incomplete medical record and follow-up, age <50 years, presence of any glenohumeral arthritis or adhesive capsulitis, and history of fracture or surgery on the affected side. In our department, anti-inflammatory drugs, activity modification, and a standardized physical therapy protocol were routinely performed in all patients with PTRCT. Subacromial corticosteroid injection was not considered for conservative management in any of the patients. When patients' symptoms were not relieved despite conservative management, the decision for surgical treatment was made by the patient after being informed of the risks and benefits of arthroscopic surgery. A minimum follow-up period of 2 years was set for patients who did not opt for surgical intervention. Eventual allocation to surgical or nonsurgical treatment was determined individually. Patients with PTRCT who did not undergo surgery during the 2-year follow-up were classified as nonsurgical allocation (group I), whereas patients who opted for surgical treatment on account of persistent symptoms despite conservative management were classified as surgical allocation (group II).

Data collection

All data were collected from the medical records of the initial visit. Patients' age, sex, body mass index (BMI), functional comorbidity index values, duration of symptoms (<6 months, 6-12 months, >12 months), and American Shoulder and Elbow Surgeons score were noted. All MRI findings were evaluated by 2 independent reviewers who were totally blinded to the treatment groups (H.A. and H.U.). The correlation coefficient between the reviewers was 0.94. Tear side (articular, bursal, and intratendinous), tear depth, Ellman classification[3] (grade I, <3 mm; grade II, 3-6 mm; grade III, >6 mm), subacromial spur, and acromiohumeral interval were noted for each patient.

Statistical analysis

Statistical analysis was performed using SPSS 20.0 software (IBM, Armonk, NY, USA). Continuous data, such as age, functional comorbidity index value, American Shoulder and Elbow Surgeons score, and acromiohumeral interval, were presented as means and standard deviations; categorical data, such as sex, BMI (normal, overweight, and obese), duration of symptoms, tear side, tear depth, and presence of subacromial spur, were presented as frequencies and percentages. The comparison of continuous data was performed by Student *t*-test, and the comparison of categorical data was performed by Pearson χ^2 or Fisher exact test. A logistic regression analysis was performed to determine the major predictors of allocation to surgery by setting operative and nonoperative groups as dependent variables. A P value $< .05$ was considered statistically significant. No sample size calculation was performed before the study; however, a post hoc power analysis was performed using the G*Power software to determine the statistical power of the study.

Table I Baseline characteristics and comparison of groups

	Group I (n = 202)	Group II (n = 70)	Combined (N = 272)	*P* value
Sex				.698
Female	135 (67)	45 (64)	180 (66)	
Male	67 (33)	25 (36)	92 (34)	
Age (yr)	62 ± 8	58 ± 9	61 ± 9	<.001
Body mass index				.997
Normal	123 (61)	49 (70)	172 (63)	
Overweight	54 (27)	21 (30)	75 (28)	
Obese	25 (12)	0 (0)	25 (9)	
Functional comorbidity index	2 ± 1	1 ± 1	1 ± 1	<.001
Duration of symptoms				.225
<6 months	135 (67)	46 (66)	181 (67)	
6-12 months	23 (11)	13 (18)	36 (13)	
>12 months	44 (22)	11 (16)	55 (20)	
ASES score	22 ± 2	22 ± 2	2 ± 2	.684

ASES, American Shoulder and Elbow Surgeons.
Categorical variables are presented as number (%). Continuous variables are presented as mean ± standard deviation.

Results

A total of 272 patients (180 women, 92 men) with a mean age of 61 ± 9 years were enrolled in this study. Group I (no-surgery group) consisted of 202 patients (135 women, 67 men) with a mean age of 62 ± 8 years, and group II (surgery group) comprised 70 patients (45 women, 25 men) with a mean age of 58 ± 9 years. The baseline characteristics of patients are shown in Table I. Significant differences were observed between groups in terms of patients' age and functional comorbidity index value. Patients' age and functional comorbidity index value were significantly higher in group I than in group II ($P < .001$ and $P < .001$, respectively; Table I).

Based on the MRI findings, significant differences were observed between groups in terms of tear side and acromiohumeral interval. Bursal-sided tears were significantly more common in group II, whereas intratendinous tears were significantly more common in group I ($P = .026$). Besides, the acromiohumeral interval was significantly higher in group I ($P = .002$; Table II).

In the logistic regression analysis model, we included age, comorbidity index value, tear side, and acromiohumeral interval to determine the major predictors of allocation to surgery. Tear side and functional comorbidity index were found as the major predictors of undergoing surgery. In patients older than 50 years with PTRCTs, patients with bursal-sided tears ($P = .015$) and fewer comorbidities ($P < .001$) were significantly more likely to undergo surgery (Table III).

Discussion

The most important findings of this study were that tear side and the patient's general health status were the major predictors of allocation to surgery in patients older than 50 years with PTRCT. However, sex, BMI, duration of symptoms, functional score, and tear size were not found as predictors of undergoing surgery for PTRCT. In contrast, as a structural factor, the tear side can also predict failed conservative management and allocation to surgery.

Operative treatment of traumatic rotator cuff tears in physically active younger patients is widely accepted; however, the literature does not suggest an algorithm for the management of rotator cuff tears, even for full-thickness tears, in older patients.[1] Defining the predictors of allocation to surgery in older patients with PTRCT is important for physicians to plan initial management of the disease and to inform the patient about the treatment algorithm. This is the first study in the literature to investigate the predictive factors of allocation to surgery in patients with PTRCTs. Previously, some authors investigated the predictors of treatment allocation in patients with full-thickness rotator cuff tears. Kweon et al[8] reported that increasing age, higher BMI, and symptom duration >1 year were predictive factors of nonsurgical treatment in their study evaluating 196 patients with a mean age similar to that in our study. However, in their multicenter study of 433 patients with full-thickness tear with a mean age of 62 years, Dunn et al[2] revealed that patients' low expectation about physical therapy is the major predictor of allocation to surgery rather than patients' symptoms and anatomic features of rotator cuff tear. In this study, we found that patients who did not undergo surgery had a significantly higher age and comorbidity index value compared with those who decided to undergo surgery. Our results are also consistent with those of previous studies investigating predictors of surgery in patients with full-thickness tear. This finding may demonstrate that patients' health situation and future physical demand and activity level play an important role in the decision of surgical intervention rather than functional scores and anatomic features of rotator cuff tear. A

Table II Comparison of magnetic resonance imaging findings of the groups

	Group I (n = 202)	Group II (n = 70)	Combined (N = 272)	*P* value
Tear side				.026
Articular	34 (17)	11 (16)	45 (16)	
Bursal	108 (53)	49 (70)	157 (58)	
Intratendinous	60 (30)	10 (14)	70 (26)	
Tear depth				.171
<3 mm	79 (39)	20 (29)	99 (36)	
3-6 mm	79 (39)	36 (51)	115 (42)	
>6 mm	44 (22)	14 (20)	58 (22)	
Tear thickness				.260
<¼ of tendon	76 (38)	20 (29)	96 (35)	
¼-½ of tendon	82 (40)	36 (51)	118 (43)	
>½ of tendon	44 (22)	14 (20)	58 (22)	
Subacromial spur				.720
Positive	190 (94)	65 (93)	255 (94)	
Negative	12 (6)	5 (7)	17 (6)	
Acromiohumeral interval (mm)	5 ± 1	6 ± 1	6 ± 1	.002

Categorical variables are presented as number (%). Continuous variables are presented as mean ± standard deviation.

Table III According to multivariate logistic regression analysis, major predictors of undergoing surgery

Variable	Logistic regression analysis	
	Odds ratio (95% confidence interval)	*P* value
Age	0.98 (0.94-1.0)	.354
Functional comorbidity index	0.47 (0.33-0.67)	<.001
Tear side		.047
Articular sided	1.84 (0.65-5.21)	.248
Bursal sided	2.75 (1.21-6.24)	.015
Acromiohumeral interval	1.32 (0.83-2.08)	.229

significantly lower comorbidity index value in patients undergoing surgery compared with those with nonoperative follow-up was also reported by Varkey et al[13] in their large population study of Medicare patients.

Both cadaveric and imaging studies showed that articular-sided partial-thickness supraspinatus tears are more common than bursal-sided tears.[4,6] Bursal-sided tears can develop from both intrinsic and extrinsic causes, but cadaveric and clinical studies showed greater associations with extrinsic factors, such as impingement with an acromial spur.[14] Limited studies on the clinical features of bursal-sided PTRCTs exist in the literature, and most studies reported clinical and radiologic results after arthroscopic repair. Bursal-sided tear is a relative indication for surgical repair, and mechanical symptoms such as painful arc, crepitus, and lock are common in this tear side.[4,15] Fukuda et al[6] also emphasized that bursal-sided PTRCTs are more painful than full-thickness tears. Besides, bursal-sided tears are highly correlated with acromial spurs, and their progression was similar to that of full-thickness tears because of the distinguished mechanical properties from articular-sided PTRCTs.[15] In a recent study, Kong et al[7] found that 13 of 81 patients (16%) with PTRCTs had tear progression, and 85% of them were bursal-sided tears. According to the results of our study, tear side and acromiohumeral interval were the significant predictors of treatment allocation according to the regression analysis. Our results demonstrated that patients with bursal-sided tears were significantly more likely to undergo surgery than those with other types of tear side. Interestingly, our results showed that patients who were allocated to surgery had higher acromiohumeral interval than those who were allocated to conservative management. This finding may be explained by the higher mean age of the patients in our no-surgery group. Increased age and decreased acromiohumeral interval may be related to each other because of the natural process of the PTRCTs; however, there is no evidence of this issue in the literature.

The main limitation of this study was its retrospective design. The duration of conservative management and patients' individual attitude to treatment allocation may be affected by several parameters. However, the retrospective design of the study also prevents potential patient selection bias. Allocation to groups and participation in the study might be affected by both the patient's and the surgeon's decision. Instead, we aimed to evaluate the natural course of patients older than 50 years of age with PTRCTs, grouped patients according to treatment allocation in a specific period, and observed those who decided not to opt for surgery during a minimum follow-up period of 2 years. Another main limitation of the study was that our data were limited to the medical records of the patients, which were obtained during the initial visit. The outcome of conservative management in terms of patients' clinical

and radiologic outcomes was not evaluated. Nevertheless, this is the first study in the literature to determine the major predictors of allocation to surgery in patients with PTRCT. Besides, a post hoc analysis was performed for significant variables, and the minimum statistical power was calculated as 0.81 for the comparison of proportions and 0.99 for the comparison of means ($\alpha = .05$). Further prospective and well-designed studies are needed to obtain more evidence and to determine the predictors of allocation to surgery in older patients with PTRCT.

Conclusions

This large retrospective study shows that in patients older than 50 years with PTRCT, those with fewer comorbidities and bursal-sided PTRCTs were significantly more likely to undergo surgery. Age was found as another significant predictor of treatment allocation. Patients with increased age were most likely to prefer nonsurgical treatment. This finding may demonstrate that patients' health situation and activity level play an important role in the decision of surgical intervention rather than functional score and tear grade. In contrast, as a structural factor, patients with bursal-sided tears should be considered potential candidates for future surgical intervention.

Disclaimer

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References

1. Downie BK, Miller BS. Treatment of rotator cuff tears in older individuals: a systematic review. J Shoulder Elbow Surg 2012;21:1255-61. https://doi.org/10.1016/j.jse.2011.11.019
2. Dunn WR, Kuhn JE, Sanders R, An Q, Baumgarten KM, Bishop JY, et al. 2013 Neer Award: predictors of failure of nonoperative treatment of chronic, symptomatic, full-thickness rotator cuff tears. J Shoulder Elbow Surg 2016;25:1303-11. https://doi.org/10.1016/j.jse.2016.04.030
3. Ellman H, Hanker G, Bayer M. Repair of the rotator cuff: end-result study of factors influencing reconstruction. J Bone Joint Surg Am 1986;68:1136-44.
4. Finnan RP, Crosby LA. Partial-thickness rotator cuff tears. J Shoulder Elbow Surg 2010;19:609-16. https://doi.org/10.1016/j.jse.2009.10.017
5. Franceschi F, Papalia R, Del Buono A, Vasta S, Costa V, Maffulli N, et al. Articular-sided rotator cuff tears: which is the best repair? A three-year prospective randomised controlled trial. Int Orthop 2013;37:1487-93. https://doi.org/10.1007/s00264-013-1882-9
6. Fukuda H, Hamada K, Nakajima T, Tomonaga A. Pathology and pathogenesis of the intratendinous tearing of the rotator cuff viewed from en bloc histologic sections. Clin Orthop Relat Res 1994:60-7.
7. Kong BY, Cho M, Lee HR, Choi YE, Kim SH. Structural evolution of nonoperatively treated high-grade partial-thickness tears of the supraspinatus tendon. Am J Sports Med 2018;46:79-86. https://doi.org/10.1177/0363546517729164
8. Kweon C, Gagnier JJ, Robbins CB, Bedi A, Carpenter JE, Miller BS. Surgical versus nonsurgical management of rotator cuff tears: predictors of treatment allocation. Am J Sports Med 2015;43:2368-72. https://doi.org/10.1177/0363546515593954
9. Lazarides AL, Alentorn-Geli E, Choi JH, Stuart JJ, Lo IK, Garrigues GE, et al. Rotator cuff tears in young patients: a different disease than rotator cuff tears in elderly patients. J Shoulder Elbow Surg 2015;24:1834-43. https://doi.org/10.1016/j.jse.2015.05.031
10. Ranalletta M, Rossi LA, Bertona AB, Atala NA, Tanoira I, Maignon G, et al. Arthroscopic transtendon repair of partial-thickness articular-side rotator cuff tears. Arthroscopy 2016;32:1523-8. https://doi.org/10.1016/j.arthro.2016.01.027
11. Schmidt CC, Jarrett CD, Brown BT. Management of rotator cuff tears. J Hand Surg Am 2015;40:399-408. https://doi.org/10.1016/j.jhsa.2014.06.122
12. Vap AR, Mannava S, Katthagen JC, Horan MP, Fritz EM, Pogorzelski J, et al. Five-year outcomes after arthroscopic repair of partial-thickness supraspinatus tears. Arthroscopy 2018;34:75-81. https://doi.org/10.1016/j.arthro.2017.07.028
13. Varkey DT, Patterson BM, Creighton RA, Spang JT, Kamath GV. Initial medical management of rotator cuff tears: a demographic analysis of surgical and nonsurgical treatment in the United States Medicare population. J Shoulder Elbow Surg 2016;25:e378-85. https://doi.org/10.1016/j.jse.2016.05.001
14. Xiao J, Cui G. Clinical and structural results of arthroscopic repair of bursal-side partial-thickness rotator cuff tears. J Shoulder Elbow Surg 2015;24:e41-6. https://doi.org/10.1016/j.jse.2014.07.008
15. Xiao J, Cui GQ, Wang JQ. Diagnosis of bursal-side partial-thickness rotator cuff tears. Orthop Surg 2010;2:260-5. https://doi.org/10.1111/j.1757-7861.2010.00097.x