Factors Affecting Prolonged Postoperative Pain and Analgesic Use After Arthroscopic Full-Thickness Rotator Cuff Repair

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Background: Postoperative pain and analgesic use after arthroscopic rotator cuff repair remain important issues that affect rehabilitation and overall outcomes.

Purpose: To evaluate the pre- and intraoperative factors that may cause prolonged duration of postoperative pain and analgesic use.

Study Design: Case-control study; Level of evidence, 3.

Methods: We included 443 patients who underwent arthroscopic rotator cuff repair and subacromial decompression. Visual analog scale (VAS) scores for pain were obtained preoperatively and at 30 and 90 days postoperatively. Patients were divided into a group who had prolonged postoperative pain (duration $\geq$1 and $<$3 months; n = 86 patients) and a group with nonprolonged pain (duration $<$1 month; n = 357 patients). The following factors were compared between groups: age, sex, body mass index, repair technique, tear size, retraction amount, repair tension, tendon degeneration, preoperative pseudoparesis, symptom duration, application of microfracture to the rotator cuff footprint for marrow stimulation, smoking, degree of fatty degeneration, preoperative narcotic analgesic use, diabetes, acromioclavicular joint degeneration, and preoperative Douleur Neuropathique 4 (DN4) and American Shoulder and Elbow Society (ASES) scores.

Results: Significant differences were seen between the prolonged and nonprolonged groups regarding the median duration of pain (54 vs 27 days, respectively; $P < .001$) and analgesic use (42 vs 28 days, respectively; $P < .001$). Significant differences were noted between the groups for symptom duration ($P = .007$), smoking status ($P = .001$), degree of fatty degeneration ($P = .009$), preoperative narcotic analgesic use ($P < .001$), preoperative DN4 and ASES scores, 30-day VAS score ($P < .001$), duration of opioid and nonopioid analgesic use ($P < .001$), tear size ($P = .026$), and retraction stage ($P = .032$). Tear size ($P = .009$), retraction amount ($P = .005$), preoperative narcotic analgesic use ($P < .001$), degree of fatty degeneration ($P < .001$), and preoperative DN4 score ($P = .024$) were factors independently associated with prolonged postoperative pain and analgesic use.

Conclusion: Patients with larger size tears, retracted tendons, preoperative use of narcotic analgesics, higher tensioned tendon after repair, and Goutallier grade 3 or 4 fatty degeneration faced an increased risk of prolonged postoperative pain and analgesic use after arthroscopic rotator cuff repair. These factors might be mitigated by psychosocial support; gentle, controlled, and individualized postoperative rehabilitation approaches; detailed preoperative evaluation; and closer follow-up of patients who are treated operatively.

Keywords: prolonged pain; postoperative; predictor; rotator cuff tear; analgesic

Postoperative pain remains an important issue in arthroscopic surgical repair of the rotator cuff.[34] Acute pain is an unpleasant physical, emotional, and mental sensation that affects quality of life, psychological status, and behavior. Postoperative pain usually continues for hours to days, rarely weeks to a month.[14] The pain should be alleviated as soon as possible to improve patients' quality of life, promote healing, allow rehabilitation, and prevent complications.[28] Although increasing evidence is available regarding methods that reduce postoperative pain, many patients experience prolonged acute postoperative pain.[12]

Several analgesic techniques have been developed for postoperative pain after arthroscopic rotator cuff repair, including cryotherapy, intralesional analgesia (injection of analgesics into the lesion), suprascapular nerve blocks with or without axillary nerve block, interscalene brachial

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plexus blocks, and indwelling interscalene catheters.[6] Although the efficacy of these techniques has been reported in several studies, they have the potential for complications and risks such as nausea, vomiting, respiratory failure, hypotension, paralysis, and dysuria and can be used for only a limited number of days.[28] Increased duration of acute postoperative pain causes increased use of opioid and nonopioid analgesics.[20] Opioid analgesics are widely accepted as the gold standard for postoperative analgesia after orthopaedic procedures.[12,38] However, opioid analgesics have several adverse effects as well as the potential for abuse. Currently, the prolonged use of opioid analgesics is a global problem.[2]

Various studies in the literature have targeted acute and chronic postoperative pain. Subjective pain tolerance, preoperative use of narcotic analgesics, smoking, and younger patient age were all found to be associated with higher acute postoperative pain scores.[8] However, high initial visual analog scale (VAS) score, acute onset of pain, and internal rotation stiffness were associated with higher scores in the late postoperative period.[16] Prolonged postoperative pain after arthroscopic surgery for rotator cuff repair has not been evaluated previously.[8,28,30,35] Therefore, it is important to identify pre- and intraoperative factors that could be associated with prolonged postoperative pain and analgesic use, allowing surgeons to manage these cases and develop subsequent strategies. This study aimed to evaluate pre- and intraoperative risk factors for prolonged postoperative pain and analgesic use after arthroscopic rotator cuff repair. Our hypothesis was that certain pre- and intraoperative factors would correlate with the subset of patients who would experience a longer duration of pain and analgesic use.

METHODS

Patients

The protocol of this retrospective case-control study was approved by an institutional ethics review board. We retrospectively collected the data of 618 patients who underwent arthroscopic rotator cuff repair performed by 2 surgeons (H.S. and A.G.) between January 2010 and August 2019 in 3 different centers.

To evaluate prolonged postoperative pain and analgesic use in a homogeneous group, we determined several inclusion and exclusion criteria. The inclusion criteria were as follows full-thickness rotator cuff tear that was repaired arthroscopically, single- or double-row repair technique, and arthroscopic subacromial decompression and biceps tenotomy in addition to rotator cuff repair. The exclusion criteria were concomitant labral or cartilage pathology (14 patients), distal clavicle excision along with rotator cuff repair (12 patients), massive tear managed with a partial repair (11 patients), concomitant glenohumeral osteoarthritis at the time of repair (11 patients), history of intraarticular injection 3 months before surgery (24 patients), preoperative shoulder stiffness (14 patients), retear development in the first postoperative 3 months (according to physical examination findings and magnetic resonance imaging) (10 patients), revision rotator cuff repair (17 patients), history of surgery for ipsilateral or contralateral upper extremity (6 patients), history of inflammatory disease (3 patients), and postoperative pain >3 months in duration (53 patients). After application of the exclusion criteria, 443 patients (314 women and 129 men; 357 nonprolonged and 86 prolonged postoperative pain and analgesic use) were included in the study.

Prolonged postoperative pain was defined as pain that continued ≥1 month but <3 months postoperatively. Prolonged postoperative analgesic use was defined as the routine use of either an opioid or nonopioid analgesic due to pain for 1 to 3 months postoperatively.

Preoperative Factors

Preoperative factors included age (<60 or ≥60 years), sex, body mass index, pseudoparesis (<90° of active elevation with free passive motion),[33] time from symptoms to surgery (duration of symptoms, months), smoking status (current and previous 1 year), degree of fatty degeneration (according to Goutallier classification),[13] history of preoperative narcotic analgesic use for >6 weeks before surgery, diabetes, acromioclavicular joint degeneration that did not require distal clavicle resection, 10-point VAS score, Douleur Neuropathique 4 (DN4) score (a score of ≥4 indicates neuropathic pain),[21] and American Shoulder and Elbow Surgeons (ASES) score.[3]

Intraoperative Factors

Intraoperative factors included repair technique (single or double row), tear size (anterior-posterior length: small, <1 cm; medium, 1-3 cm; large, >3 to 5 cm; and massive, >5 cm),[29] retraction amount (stage 1, proximal stump close to enthesis or bony insertion; stage 2, proximal stump at humeral head; stage 3, proximal stump at glenoid),[26] tendon degeneration (mild to moderate degeneration or severe

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degeneration according to macroscopic appearance), and application of microfracture to the rotator cuff footprint for marrow stimulation.

Surgical Technique and Rehabilitation

All surgical procedures were performed with patients receiving a combination of interscalene block and general anesthesia. Patients were positioned in the beach-chair position. Diagnostic arthroscopy was performed prior to the repair process. All long heads of the bicep tendons underwent tenotomy (older patients, ≥60 years) or tenodesis (younger patients, <60 years). Then the arthroscope was placed into the subacromial space, and a bursectomy was performed to elucidate the tear pattern. A single- or double-row repair technique was used according to tear size and configuration. Repairs were performed using TwinFix suture anchor with UltraBraid suture or Footprint PK suture anchor (Smith & Nephew). Subacromial decompression and release of anterior aspect of the coracoacromial ligament were performed after rotator cuff repair.

An immobilizer was used postoperatively for 6 weeks. Pendulum exercises were started immediately postoperatively. For the first 6 weeks, patients were allowed to perform pendulum exercises with active elbow, wrist, and hand involvement for 10 minutes, 3 times a day. Passive range of motion was allowed at weeks 6 through 8, active-assisted range of motion at weeks 8 through 10, and active range of motion at weeks 10 through 12. A strengthening program was started at the 12th week. The rehabilitation program was formalized and guided by a therapist.

Assessment of Postoperative Pain and Analgesic Use

Postoperative analgesics for all patients during hospitalization included 50 mg of tramadol and 500 mg of acetaminophen every 6 to 8 hours. After discharge, patients were prescribed 2 or 3 50-mg tramadol pills twice a day and 1 or 2 500-mg acetaminophen pills every 12 hours, in combination with 750 mg of naproxen once a day.

Patients' pain levels at rest as well as their range of motion were assessed at 30 and 90 days postoperatively during clinic visits. The 10-point VAS scale was used in the pain assessment, in which 0 indicated no pain and 10 indicated the worst pain. Patients were also asked to mark the last time they regularly used analgesics (opioids and others separately) on the 30- and 90-day calendars.

Statistical Analysis

The mean, standard deviation, median, lowest and highest, frequency, and ratio values were used in descriptive statistics of data. Distribution of variables was determined using the Kolmogorov-Smirnov test. The independent-samples t test and Mann-Whitney U test were used to analyze independent quantitative data, and the chi-square test was used to analyze independent qualitative data. The Pearson correlation coefficient (r) was used to evaluate correlation between factors; r was defined as very strong when >0.90, strong between 0.70 and 0.90, moderate between 0.50 and 0.70, fair between 0.30 and 0.50, and negligible when <0.30.[25]

Uni- and multivariate logistic regression analyses were performed to define independent pre- and intraoperative risk factors for prolonged pain and analgesic use after arthroscopic rotator cuff repair. $P < .05$ was considered statistically significant. SPSS Version 22.0 (IBM) was used in all statistical analyses.

TABLE 1
Patient Characteristics Overall and Compared Between Groups[a]

	All Patients (N = 443)	Nonprolonged Pain and Analgesic Use (n = 357; 80.6%)	Prolonged Pain and Analgesic Use (n = 86; 19.4%)	P
Age				.574
<60 y	184 (41.5)	145 (40.6)	39 (44.8)	
≥60 y	259 (58.5)	212 (59.4)	47 (55.2)	
Sex				.088
Female	314 (70.9)	261 (73.1)	53 (61.6)	
Male	129 (29.1)	96 (26.9)	33 (38.4)	
Body mass index, kg/m^2	28.5 ± 3.0	28.3 ± 3.0	28.8 ± 3.2	.763
Symptom duration, mo	10.3 ± 8.4	9.2 ± 7.7	10.8 ± 8.0	**.007**
Smoker				**.001**
Yes	85 (19.2)	56 (15.6)	29 (33.7)	
No	358 (80.8)	301 (84.4)	57 (66.3)	

[a]Data are reported as n (%) or mean ± SD. Bolded P values indicate statistically significant differences between the 2 groups.

RESULTS

This study included 443 patients who underwent arthroscopic repair for a full-thickness rotator cuff tear. The mean age of the included patients was 60.1 ± 9.5 years (range, 27-78 years). Patients were evaluated for at least 6 months postoperatively (range, 6-87 months). Patient information is provided in Table 1.

Retear developed in 13 patients (15.1%) in the group with prolonged pain and in 41 patients (11.5%) in the group with nonprolonged pain ($P = .296$). Postoperative shoulder stiffness developed in 16 patients (18.6%) with prolonged pain and in 57 patients (16.0%) with nonprolonged pain ($P = .774$). Table 2 shows the results of the pre-, intra-, and postoperative clinical evaluations and the mean opioid and nonopioid analgesic use.

Significant difference were seen between the prolonged and nonprolonged groups regarding the median duration of pain (54 vs 27 days, respectively; $P < .001$) and analgesic use (42 vs 28 days, respectively; $P < .001$). Significant differences were noted in the duration of symptoms ($P = .007$), smoking status ($P = .001$), degree of fatty degeneration (Goutallier grade >2) ($P = .009$), preoperative narcotic analgesic use ($P < .001$), preoperative DN4 score ($P < .001$), preoperative ASES score ($P < .001$), 30-day

TABLE 2
Pre-, Intra-, and Postoperative Clinical Characteristics Overall and Compared Between Groups[a]

	All Patients (N = 443)	Nonprolonged Pain and Analgesic Use (n = 357; 80.6%)	Prolonged Pain and Analgesic Use (n = 86; 19.4%)	*P* Value
Pseudoparesis				.455
Yes	104 (23.5)	81 (22.6)	23 (26.7)	
No	339 (76.5)	276 (77.4)	63 (73.3)	
Goutallier degree of fatty degeneration				
1	115 (26.0)	105 (29.4)	10 (11.6)	**.026**
2	206 (46.5)	177 (49.6)	29 (33.7)	**.047**
3	107 (24.1)	68 (19.0)	39 (45.4)	**.001**
4	15 (3.4)	7 (2.0)	8 (9.3)	**.009**
Preoperative narcotic analgesic use				**<.001**
Yes	83 (18.8)	32 (9.9)	51 (59.3)	
No	360 (81.2)	325 (90.1)	35 (40.7)	
Diabetic				.168
Yes	111 (25.1)	83 (23.3)	28 (32.5)	
No	332 (74.9)	274 (76.7)	58 (67.5)	
Mild or moderate symptomatic acromioclavicular joint degeneration				.222
Yes	147 (43.4)	113 (31.6)	34 (34.3)	
No	296 (56.6)	244 (68.4)	52 (65.7)	
Preoperative DN4 score	2 [0-9]	1 [0-3]	6 [4-9]	**<.001**
Preoperative ASES score	44.6 ± 16.1	47.0 ± 15.5	33.7 ± 13.1	**<.001**
Preoperative VAS score	6 [4-10]	6 [4-10]	7 [5-10]	.376
30-day VAS score	4 [2-10]	4 [2-10]	7 [3-10]	**<.001**
90-day VAS score	2 [1-9]	2 [1-4]	3 [1-9]	.207
In-hospital opioid analgesic requirement, times per day	3 [2-6]	3 [2-6]	4 [2-6]	.519
In-hospital nonopioid analgesic requirement, times per day	2 [1-4]	2 [2-4]	3 [1-4]	.096
Duration of opioid analgesic use after discharge, days	21 [5-79]	15 [5-15]	36 [6-79]	**<.001**
Duration of nonopioid analgesic use after discharge, days	28 [4-72]	28 [10-28]	42 [4-72]	**<.001**
Patients using opioid analgesics >30 days	37 (8.4)	6 (1.7)	31 (36.0)	**<.001**
Repair technique				.677
Single row	176 (39.7)	144 (40.4)	32 (37.2)	
Double row	267 (60.3)	213 (59.6)	54 (62.8)	
Tear size				**.026**
Small (<1 cm)	64 (14.5)	49 (13.7)	15 (17.5)	
Medium (1-3 cm)	204 (46.0)	175 (49.0)	29 (33.7)	
Large (>3-5 cm)	147 (33.2)	126 (35.3)	21 (24.4)	
Massive (>5 cm)	28 (6.3)	7 (2.0)	21 (24.4)	
Retraction amount				**.032**
Stage 1	187 (42.2)	155 (43.4)	32 (37.1)	
Stage 2	203 (45.7)	168 (45.7)	35(37.1)	
Stage 3	58 (13.1)	39 (10.9)	19 (35.8)	
Tendon degeneration				.819
Yes	135 (30.5)	107 (30.0)	28 (32.6)	
No	308 (69.5)	250 (70.0)	58 (67.4)	
Microfracture to the rotator cuff footprint for marrow stimulation				.107
Yes	369 (83.3)	303 (84.8)	66 (76.7)	
No	74 (16.7)	54 (15.2)	20 (23.3)	

[a]Data are reported as mean ± SD, n (%), or median [range]. Bolded *P* values indicate statistically significant differences between the 2 groups. ASES, American Shoulder and Elbow Surgeons; DN4, Douleur Neuropathique 4;VAS, visual analog scale.

VAS score ($P < .001$), duration of opioid and nonopioid analgesic use ($P < .001$ for both), tear size ($P = .026$), and retraction stage ($P = .032$) between patients with prolonged and nonprolonged pain and analgesic use (Tables 1 and 2).

Tear size ($P = .009$), amount of tendon retraction ($P = .005$), preoperative use of narcotic analgesics >6 weeks ($P < .001$), degree of fatty degeneration ($P < .001$), and preoperative DN4 score ≥ 4 ($P = .024$) were found to be independently associated with prolonged postoperative pain and analgesic use in the multivariate logistic regression analysis (Table 3).

DISCUSSION

The most important findings of this study were that patients with a larger tear size, higher amount of tendon

TABLE 3
Pre- and Intraoperative Factors Affecting Prolonged Postoperative Pain and Use of Analgesics[a]

Variable	Odds Ratio	*P*
Tear size >3 cm	1.736	**.009**
Stage 3 retraction	2.115	**.005**
Preoperative narcotic analgesic use >6 weeks	6.999	**<.001**
Goutallier grade 3 and 4 fatty degeneration	7.018	**<.001**
Preoperative DN4 score ≥4	2.232	**.024**
Symptom duration >6 months	0.809	.654
Preoperative ASES score ≥35	0.919	.746

[a]Bolded *P* values indicate statistical significance. ASES, American Shoulder and Elbow Surgeons; DN4, Douleur Neuropathique 4.

retraction, preoperative narcotic analgesic use >6 weeks, Goutallier grade 3 or 4 fatty infiltration, or preoperative DN4 score ≥4 tended to have prolonged (30-90 days postoperatively) postoperative pain and analgesic use after arthroscopic rotator cuff repair. Fatty infiltration and DN4 score were studied as risk factors for the first time in the evaluation of postoperative pain after arthroscopic rotator cuff repair.

Among shoulder arthroscopy procedures, rotator cuff surgery is the most painful procedure in the early postoperative period.[32] The factors associated with early and late postoperative pain levels were previously identified. Cuff et al[8] reported that subjective pain tolerance, preoperative use of narcotic analgesics, smoking, and young patient age were predictive of higher acute postoperative pain scores. Kim et al[16] evaluated factors that affect pain in the first year postoperatively and reported that a high initial VAS score, acute onset of pain, and internal rotation stiffness were associated with higher than mean pain scores in the first 12 months. In our study, tear size (>3 cm), stage 3 tendon retraction, preoperative use of narcotic analgesics (>6 weeks), fatty degeneration (grade 3 and 4), and preoperative DN4 score (≥4) were independently associated with the development of prolonged postoperative pain and analgesic use after arthroscopic repair of full-thickness rotator cuff tears.

Acute postoperative pain generally lasts for days; it rarely persists for >1 month. Pain is defined as chronic if it lasts for >3 months.[36] We identified prolonged acute postoperative pain as lasting between 1 and 3 months. Prolonged acute postoperative pain causes delayed recovery and impairs quality of life.[18] In addition, the risk of analgesic-related morbidities increases with prolonged acute pain.[10]

In contrast to our study and the generally accepted idea that postoperative pain duration is correlated with tear size, Yeo et al[40] showed that smaller rotator cuff tears (in terms of both tear area and thickness) were associated with more pain at 6 weeks, 3 months, and 6 months postoperatively.[40] This finding may be attributed to increased neoangiogenesis, new nerve growth, and inflammation after repair of smaller tears.[22,24,39] New nerve fibers are more prone to pain sensitivity, as previously shown in Achilles tendinopathy, intervertebral disk pathology, and rotator cuff tears.[11,23,31] However, in our study, we found a 1.736-fold increased risk for prolonged postoperative acute pain and analgesic use in tears >3 cm in size. There may be other factors, such as degree of preoperative tendon degeneration, that are associated with prolonged postoperative pain.

Pulling the edge of the retracted rotator cuff tendon to the bone and then fixing the tendon to the bone may cause tension in the repair site and increased neural stimuli.[9] Davidson and Rivenburgh[9] reported that elevated tension of the repair was associated with worse postoperative pain scores. In our study, a 2.115-fold increased risk of prolonged acute postoperative pain was found in stage 3 retracted tears. Proper release of retracted tendon may decrease repair tension and postoperative duration of pain.

History of preoperative narcotic analgesic use of >6 weeks was previously reported to be associated with higher acute postoperative pain levels and with possible hyperalgesia.[7,8] Moreover, such a history was associated with postoperative adverse events and worse clinical outcomes.[13,19,27,41] In our study, we found 6.999-fold increased risk of prolonged acute postoperative pain in patients with a history of preoperative narcotic analgesic use >6 weeks.

Fatty degeneration and atrophy of the rotator cuff muscles have previously been identified as important prognostic factors for anatomic and functional outcomes after rotator cuff repair.[1] However, the effect of the degree of fatty infiltration on acute postoperative pain has not been previously evaluated. Degenerative changes such as atrophy and shrinkage of the muscle fibers, increased fibrosis, fatty accumulation around the muscle, and decreased regeneration capacity may play a role in the duration of postoperative pain after arthroscopic rotator cuff repair. In this study, we found a 7.018-fold increased risk of prolonged acute postoperative pain in patients with Goutallier grade 3 and 4 fatty degeneration. To the best of our knowledge, this is the first study to evaluate the association between the degree of fatty degeneration and prolonged postoperative pain and analgesic use. Our data could be used as a reference for future investigations to predict patients who will experience prolonged postoperative pain and analgesic use after arthroscopic rotator cuff repair.

Neuropathic pain is a distressing condition, and the management thereof is difficult. The prevalence of neuropathic pain in the general population has been estimated to be 7%.[4] In patients with rotator cuff tears, the prevalence of neuropathic pain has been found to be as high as 15.8%.[15,17,18] The DN4 score is a reliable, validated, quick, and sensitive tool for evaluating neuropathic pain.[37] However, the effect of neuropathic pain on acute pain and analgesic use after surgery has never before been evaluated. In our study, we found neuropathic pain in 18.3% of patients. We found a 2.232-fold increased risk of prolonged acute postoperative pain in patients with a preoperative DN4 score ≥4. To achieve improved patient satisfaction, effective pain control, and proper analgesic use in patients with rotator cuff tear, surgeons may evaluate neuropathic pain using the DN4 score preoperatively.

There are several limitations of this study, the major one being its retrospective nature. Moreover, we included only full-thickness tears, and the levels and duration of pain might be different from those after the repair of partial-thickness rotator cuff tears. The postoperative pain regimen was nonstandardized. Pain reporting did not include a finite method such as a pain diary. Variability in the patients' adherence to the physical therapy program probably had a large effect on postoperative pain duration. Muscular imbalance, a possible cause of prolonged postoperative pain, was not assessed. Psychosocial factors might affect patients' pain status; therefore, using the 36-Item Short Form Health Survey to evaluate quality of life would be beneficial. Early postoperative VAS evaluation would give more objective comparative results. Finally, some factors such as smoking could not be defined as independent risk factors, a result that might be associated with the close correlation between smoking and preoperative use of narcotic analgesics. Independence depends on the variable included in a model. In the simultaneous presence of 2 closely correlated factors in a model, 1 or both may lose the ability of independent prediction, even if both variables are highly significant independent risk factors.[5]

CONCLUSION

Larger size tears, retracted tendons, preoperative use of narcotic analgesics, higher tensioned tendon after repair, and Goutallier grade 3 or 4 fatty degeneration are independent risk factors for prolonged postoperative pain and analgesic use after arthroscopic rotator cuff repair. These factors might be mitigated by psychosocial support; gentle, controlled, and individualized postoperative rehabilitation approaches; detailed preoperative evaluation; and closer follow-up of patients who are treated operatively.

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