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TABLE E-1 Preoperative Demographics According to the Direction of Change in Area

Variable	Increased (N = 29)	Decreased (N = 59)	P Value
Age* *(yr)*	60.41 ± 9.97	59.76 ± 8.04	0.743
Sex, M:F	12:17	19:40	0.397
Side, R:L	20:9	49:10	0.131
Dominance, Y:N	17:12	51:8	0.003
Duration* *(mo)*	11.54 ± 14.06	34.73 ± 64.18	0.058
Aggravation* *(mo)*	2.82 ± 1.64	5.02 ± 8.69	0.335
Clinical follow-up* *(mo)*	13.14 ± 2.10	12.73 ± 2.58	0.512
MRI follow-up* *(mo)*	11.76 ± 4.90	11.41 ± 4.02	0.721

*The values are given as the mean and the standard deviation.

TABLE E-2 Range of Motion According to the Direction of Change in Area

Motion	Increased (N = 29)* *(deg)*	Decreased (N = 59)* *(deg)*	P Value
Forward flexion			
Preop.	119.48 ± 44.19	139.32 ± 40.38	0.039
3 mo	123.20 ± 26.88	119.12 ± 37.80	0.266
6 mo	144.80 ± 22.24	149.45 ± 33.05	0.818
12 mo	164.23 ± 23.65	162.19 ± 27.68	0.299
Abduction			
Preop.	106.03 ± 49.32	138.81 ± 47.24	0.003
3 mo	104.20 ± 33.44	101.84 ± 42.84	0.244
6 mo	134.60 ± 33.10	145.09 ± 39.05	0.729
12 mo	163.46 ± 25.80	160.26 ± 34.41	0.093
External rotation with arm at side			
Preop.	38.97 ± 20.33	44.41 ± 18.13	0.207
3 mo	20.40 ± 19.41	22.72 ± 18.18	0.880
6 mo	29.40 ± 16.98	35.18 ± 19.95	0.382
12 mo	46.54 ± 21.53	43.42 ± 20.86	0.368
Internal rotation			
Preop.	6.34 ± 4.31	8.47 ± 3.57	0.016
3 mo	5.32 ± 3.39	4.95 ± 3.01	0.479
6 mo	7.24 ± 3.53	7.49 ± 3.11	0.736
12 mo	8.81 ± 3.01	9.32 ± 2.42	0.838

*The values are given as the mean and the standard deviation.

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TABLE E-3 Clinical Outcome Scores According to the Direction of Change in Area

Variable	Increased (N = 29)*	Decreased (N = 59)*	P Value
ASES			
Preop.	43.72 ± 19.73	49.19 ± 18.74	0.209
3 mo	54.83 ± 15.85	52.18 ± 17.28	0.364
6 mo	70.10 ± 16.24	70.03 ± 17.53	0.597
12 mo	84.99 ± 15.99	81.80 ± 17.96	0.289
Constant			
Preop.	40.25 ± 19.42	49.61 ± 14.46	0.013
3 mo	44.21 ± 15.26	41.04 ± 16.08	0.138
6 mo	57.89 ± 15.17	58.74 ± 16.86	0.455
12 mo	71.28 ± 15.46	68.58 ± 15.08	0.080
UCLA			
Preop.	14.72 ± 5.19	16.19 ± 4.69	0.188
3 mo	19.80 ± 4.77	20.02 ± 6.31	0.940
6 mo	24.88 ± 5.60	24.69 ± 5.92	0.703
12 mo	29.69 ± 5.33	27.88 ± 6.30	0.095
DASH			
Preop.	52.67 ± 23.34	44.19 ± 21.90	0.098
3 mo	39.87 ± 19.14	42.34 ± 19.20	0.290
6 mo	26.03 ± 15.71	26.48 ± 18.58	0.430
12 mo	12.12 ± 15.24	17.19 ± 17.72	0.067
SST			
Preop.	3.79 ± 2.90	5.53 ± 2.74	0.008
3 mo	5.20 ± 2.25	4.68 ± 2.83	0.125
6 mo	6.96 ± 2.95	7.85 ± 3.86	0.725
12 mo	9.65 ± 2.78	9.19 ± 2.68	0.056
SPADI			
Preop.	56.21 ± 23.30	49.32 ± 22.64	0.187
3 mo	48.05 ± 20.18	49.01 ± 21.51	0.664
6 mo	29.11 ± 16.45	31.69 ± 19.22	0.215
12 mo	14.12 ± 16.12	16.77 ± 18.39	0.297

*The values are given as the mean and the standard deviation.

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TABLE E-4 MRI Findings According to the Direction of Change in Area

Variable	Increased (N = 29)	Decreased (N = 59)	P Value
Preop.			
Fatty infiltration, 0:1:2:3:4			
Supraspinatus	2:6:13:4:4	2:19:17:5:16	0.539
Infraspinatus	6:12:10:1:0	4:33:14:3:5	0.142
Subscapularis	10:16:2:0:1	15:35:6:2:1	0.456
GFDI*	1.37 ± 0.77	1.58 ± 0.88	0.280
Occupation ratio, 1:2:3	10:13:6	22:20:17	0.766
Tangent sign, 1:2:3	17:8:4	30:23:6	0.791
Immediately postop.			
Fatty infiltration, 0:1:2:3:4			
Supraspinatus	2:9:14:4:0	2:24:22:10:1	0.835
Infraspinatus	8:12:8:1:0	5:39:9:5:1	0.240
Subscapularis	8:19:2:0:0	15:33:9:2:0	0.268
GFDI*	1.18 ± 0.64	1.33 ± 0.68	0.344
Occupation ratio, 1:2:3	10:17:2	24:35:0	0.275
Tangent sign, 1:2:3	25:4:0	54:5:0	0.442
1 year postop.			
Fatty infiltration, 0:1:2:3:4			
Supraspinatus	2:13:13:1:0	2:15:26:11:5	0.005
Infraspinatus	6:13:10:0:0	1:35:16:1:6	0.029
Subscapularis	6:19:3:1:0	8:33:12:4:2	0.080
GFDI*	1.18 ± 0.58	1.64 ± 0.80	0.007
Occupation ratio, 1:2:3	17:12:0	25:28:6	0.060
Tangent sign, 1:2:3	26:3:0	38:15:6	0.010

*The values are given as the mean and the standard deviation.

TABLE E-5 Operative Findings According to the Direction of Change in Area

Variable	Increased (N = 29)	Decreased (N = 59)	P Value
SLAP, none:I:II+	18:1:10	39:4:16	0.675
Subscapularis tear grade, 0:1:2:3	11:9:8:1	20:20:13:6	0.780
Biceps tear, none:partial:complete:dislocation	15:8:4:2	30:23:6:0	0.171
1 row:2 rows	3:26	5:54	0.774
Labrum, not done:debrided:repaired	20:8:1	42:12:5	0.553
Subscapularis, not done:debrided:repaired	13:13:3	20:25:14	0.294
Biceps, not done:tenodesed:debrided:tenotomized	18:0:2:9	36:1:6:16	0.842
Anteroposterior size* *(mm)*	28.21 ± 16.81	31.90 ± 20.73	0.407
Mediolateral size* *(mm)*	15.69 ± 10.96	20.41 ± 13.59	0.108
Cofield type, small:medium:large:massive	3:14:8:4	7:24:11:17	0.378
Boileau stage, I:II:III:IV	17:3:5:4	19:15:9:16	0.062
Tendon grade, A:B:C†	12:16:1	13:29:17	0.005
Acromioplasty, Y:N	7:22	14:45	0.966
Greater tuberosity medialization, Y:N	3:26	14:45	0.135
Multiple channeling, Y:N	19:10	39:20	0.957
Application of PRP, Y:N	12:17	21:38	0.598
Greater tuberosity coverage, A:B:C:D	21:5:3:0	34:14:7:4	0.129

*The values are given as the mean and the standard deviation. †The tendon grade was assessed on the basis of gross appearance at the time of surgery with respect to three criteria: (1) fraying of more than one-half of the tendon thickness, (2) delamination, and (3) thinning to less than one-half of the thickness of the normal rotator cuff (i.e., <6 mm). Gross tendon quality was graded as A if none of these criteria were met, as B if fraying or delamination was identified, and as C if both fraying and delamination were identified or if thinning (with or without the other two criteria) was identified.

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TABLE E-6 Pain According to the Direction of Change in Area

Variable	Increased (N = 29)*	Decreased (N = 59)*	P Value
Pain at rest			
Preop.	3.38 ± 2.30	4.17 ± 2.67	0.176
3 mo	2.66 ± 2.15	2.86 ± 2.38	0.940
6 mo	1.24 ± 1.51	1.64 ± 1.80	0.422
12 mo	0.63 ± 1.02	0.95 ± 1.52	0.374
Pain with motion			
Preop.	5.93 ± 2.55	5.83 ± 2.70	0.875
3 mo	4.68 ± 2.42	4.92 ± 2.38	0.644
6 mo	3.36 ± 2.11	3.07 ± 2.07	0.548
12 mo	1.43 ± 1.95	1.74 ± 2.08	0.520
Pain at night			
Preop.	5.53 ± 2.71	5.73 ± 3.16	0.777
3 mo	4.56 ± 2.60	4.60 ± 2.62	0.955
6 mo	2.74 ± 2.00	2.63 ± 2.00	0.848
12 mo	1.17 ± 1.54	1.67 ± 1.99	0.283
Average pain			
Preop.	4.84 ± 1.98	4.74 ± 2.05	0.829
3 mo	3.65 ± 1.63	3.95 ± 1.91	0.437
6 mo	2.45 ± 1.50	2.44 ± 1.69	0.920
12 mo	1.08 ± 1.31	1.45 ± 1.62	0.311
Pain at worst			
Preop.	8.11 ± 2.26	8.58 ± 1.74	0.403
3 mo	6.29 ± 3.01	5.99 ± 2.34	0.267
6 mo	4.43 ± 2.34	4.64 ± 2.54	0.371
12 mo	2.67 ± 2.44	2.94 ± 2.66	0.575

*The values are given as the mean and the standard deviation.

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TABLE E-7 Patient Satisfaction According to the Direction of Change in Area

Variable	Increased (N = 29)	Decreased (N = 59)	P Value
Would undergo the surgery again *(%)*			
3 mo	48	51	0.810
6 mo	68	64	0.704
12 mo	73	79	0.583
Would recommend the surgery *(%)*			
3 mo	68	66	0.865
6 mo	72	87	0.096
12 mo	81	84	0.723
Able to work as before the injury *(%)*			
Preop.	59	64	0.639
3 mo	56	61	0.646
6 mo	72	66	0.562
12 mo	83	85	0.807
Overall function*			
Preop.	3.52 ± 1.72	4.15 ± 2.36	0.209
3 mo	5.20 ± 1.68	4.88 ± 1.85	0.277
6 mo	6.00 ± 2.03	6.19 ± 1.97	0.885
12 mo	7.71 ± 1.81	7.24 ± 2.41	0.177
Overall satisfaction*			
3 mo	60.80 ± 23.57	66.05 ± 22.24	0.336
6 mo	68.20 ± 24.45	72.36 ± 22.21	0.454
12 mo	78.46 ± 20.48	79.30 ± 24.50	0.880

*The values are given as the mean and the standard deviation.

Appendix E-1 Surgical Procedure and Outcome Assessments

Briefly, systematic glenohumeral joint and subacromial exploration was performed and the lesions were managed as necessary. In each case, after removing the frayed and atrophied torn end, the rotator cuff tear was carefully evaluated and the anteroposterior size, mediolateral retraction, number of involved tendons, and gross tendon grade were documented[31]. If excursion of the torn end was inadequate, tendon mobilization procedures (including superior capsulotomy, coracohumeral ligament release, and medialization of the supraspinatus insertion in the greater tuberosity) were performed[31,32]. The footprint of the greater tuberosity was debrided and only a minimal layer of cortical bone was removed. Rotator cuff repair was performed with use of a suture bridge technique, as allowed by tension. The number of anchors used depended on tear size; generally, two or three anchors were used for small and medium tears, and three to five were used for large and massive tears. Medial row anchors were first inserted just lateral to the articular surface of the humeral head, and sutures were then threaded through the rotator cuff. Sutures were tied securely with use of the SP (slippage-proof) knot[33,34], and the lateral row was then secured with use of a suture bridge technique. In thirty-three patients, platelet-rich plasma was used to augment healing[32]. After repair, greater tuberosity coverage of the repaired tendon was measured to evaluate the repair status as described previously[31]. Postoperative rehabilitation was performed as described previously[32].

Appendix E-2 MRI Protocol

MRI was performed with use of a 3.0-T scanner (Achieva 3.0T; Philips Medical Systems, Eindhoven, The Netherlands) with a dedicated shoulder coil. The arm was placed at the side of the body in a neutral position, and efforts were made to maintain a consistent position throughout the study. Assessment was made with use of image processing software (Marosis M-View 5.4; INFINITT Healthcare, Seoul, South Korea) on a T1-weighted oblique sagittal-plane image (TR/TE, 521.8/20; matrix, 356 × 258; slice thickness, 4 mm; interslice gap, 0.4 mm; field of view, 16 × 16 cm) where the coracoid process and the scapular spine meet the scapular body (Y-section). This position has been used commonly in previous studies and is known to be easily reproducible[35-38].

Appendix E-3 Range of Motion According to the Direction of Change in Area (Table E-2)

At three months postoperatively, forward flexion, abduction, and internal rotation had not changed significantly from the preoperative value and external rotation with the arm at the side had decreased significantly in the group that improved, whereas the range of motion in each plane decreased significantly from the preoperative value in the group that worsened. At six months postoperatively, forward flexion and abduction had improved significantly, internal rotation had remained unchanged from the preoperative value, and external rotation with the arm at the side was still significantly decreased in the group that improved. In the group that worsened, forward flexion, abduction, and internal rotation had recovered to the preoperative value, whereas external rotation with the arm at the side remained decreased. At one year postoperatively, forward flexion, abduction, and internal rotation had improved significantly in both groups, whereas external rotation with the arm at the side remained unchanged compared with the preoperative value.

Appendix E-4 Strength According to the Direction of Change in Area (Table II)

At three months postoperatively, the strengths of the supraspinatus, infraspinatus, and subscapularis did not differ significantly from the preoperative values in the group that improved, whereas those of the supraspinatus and infraspinatus had decreased significantly in the group that worsened ($p < 0.001$ for both). At six months postoperatively, the strengths of the supraspinatus and subscapularis had increased significantly ($p = 0.001$ and $p = 0.016$, respectively) and that of the infraspinatus remained unchanged in the group that improved. In the group that worsened, the strength of the subscapularis had increased significantly and that of the supraspinatus had improved to the preoperative level, whereas that of the infraspinatus remained significantly decreased ($p = 0.024$). At one year postoperatively, the strengths of the supraspinatus and subscapularis were significantly greater than the preoperative values in the group that improved, whereas that of the infraspinatus remained unchanged. In the group that worsened, the strength of the subscapularis had improved significantly, whereas those of the supraspinatus and infraspinatus had not.

Appendix E-5 Clinical Outcomes According to the Direction of Change in Area (Table E-3)

At three months postoperatively, the ASES, UCLA, DASH, and SST scores had improved significantly compared with the preoperative values in the group that improved, whereas the Constant and SPADI scores had not. In the group that worsened, only the UCLA score had improved significantly ($p < 0.001$), whereas the ASES, DASH, SST, and SPADI scores had not changed and the Constant score had worsened significantly ($p = 0.002$). At six months postoperatively and continuing to the time of final follow-up at one year, all scores in both groups had improved significantly compared with the preoperative values. ■

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