Original Article Clinics in Orthopedic Surgery 2017;9:77-82 • https://doi.org/10.4055/cios.2017.9.1.77

Outcomes of Rotator Cuff Repair in Patients with Comorbid Disability in the Extremities

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Background: Rehabilitation and overuse of the shoulder after rotator cuff repair are a concern in patients with comorbid disability in other extremities. Improvement of outcomes can be hampered in this situation. This study was to describe the clinical outcomes of rotator cuff repair in patients with comorbid disability in other extremities.

Methods: In two tertiary institutions, 16 patients with comorbid disability (9 men and 7 women; mean age of 57.1 years [range, 45 to 71 years]; 14 dominant arms; mean follow-up of 18 months [range, 12 to 38 months]) underwent rotator cuff repair. There were 5 massive tears, 1 large tear, 9 medium tears, and 1 small tear. Open repair was performed in 3 patients and arthroscopic repair in 13. The most common comorbid condition was paralysis (n = 7). Eight patients walked with crutches preoperatively. Anatomical outcome was investigated in 12 patients using either magnetic resonance imaging or ultrasonography at least 6 months postoperatively.

Results: Range of motion, visual analogue scale for pain and satisfaction, and all functional scores improved significantly. Healing failure occurred in 4 patients (2 large-to-massive and 2 medium size tears), but none required revision surgery. All 4 retears involved the dominant side, and 3 patients were crutch users.

Conclusions: The current data suggested favorable outcome of rotator cuff repair in patients with comorbid disability. Careful surgical planning and rehabilitation is particularly important for crutch users and in the case of dominant arm involvement in disabled patients.

Keywords: *Rotator cuff, Disability, Paralysis, Treatment outcome*

Patients with spinal cord injury perform weight-relief raises and transfers to relieve the buttocks from the body weight. The upper extremities are also often used to perform overhead tasks while sitting, which produces an upward translation of the humeral head and causes an impingement of the subacromial structures against the acromion.[1-3] For these reasons, shoulder pain is common in these patients, with the incidence ranging from 30% to 67%. In a previous study, the prevalence of rotator cuff tears was significantly higher in paraplegic patients than in able-bodied volunteers (63% vs. 15%).[1] Among individuals with spinal cord injury who exhibited shoulder pain, the prevalence of rotator cuff tears was 65% to 71%.[4] Furthermore, both the prevalence and intensity of shoulder pain has been shown to be significantly higher in patients with tetraplegia than in patients with paraplegia.[5]

As reported in a previous study, only 10% of patients with paraplegia received surgical treatment for shoulder pain due to concern about the invasiveness of the surgery.[6] Rehabilitation is also a concern in these patients because of their activities of daily living. Improvement of outcomes could be hampered in this situation, and few reports on the outcomes of rotator cuff repair in patients with spinal

Received March 21, 2016; Accepted August 23, 2016
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cord injury have been published.[4,7-10]

Shoulder problems occur not only in patients with spinal cord injury but also in patients with comorbid disability in the extremities. Excessive shoulder stress in activities of daily living results in shoulder pain and rotator cuff tear in these patients as well. However, the number of reports of rotator cuff repair in patients with comorbid disability in the extremities is also limited. Therefore, the purpose of this study was to describe the authors' clinical experience with rotator cuff repair and to analyze functional and radiographic outcomes in patients with comorbid disability in the extremities. The hypothesis of this study was that rotator cuff tear patients with comorbid disability in the extremities would exhibit less favorable clinical outcomes.

METHODS

We retrospectively reviewed the data of patients with comorbid disability who underwent rotator cuff repair between October 2006 and March 2014 in two tertiary institutions. After obtaining Institutional Review Board approval (No. KMC IRB 1522-15, No. B-1508/312-120) from Kyung Hee University Hospital and Seoul National University Bundang Hospital to review the patients' charts, the retrospective study was initiated. Patients with comorbid disability who had a full-thickness rotator cuff tear confirmed by clinical examination and magnetic resonance imaging (MRI) were included in the current study. Comorbid disability conditions were weakness, paralysis, or amputation in the upper and/or lower extremity. Patients with infections of the affected shoulder, previous surgery on either shoulder, general paralysis due to motor nerve disease, cervical or thoracic syringomyelia, or advanced degenerative joint disease of the spine were excluded. Rotator cuff repair was performed by two senior surgeons (YGR and JHO). All patients failed to obtain symptom relief by conservative treatments such as medication or physical therapy for at least 3 months. All patients were advised to use electric wheelchairs and perform only assisted transfers for the first 6–8 postoperative weeks in accordance with the tear size. Independent transfers and manual wheelchair use were permitted 10–12 weeks after surgery.

The first author (YGR) performed all procedures including open rotator cuff repair with the patient in the beach-chair position under general hypotensive anesthesia. The second author (JHO) performed all procedures arthroscopically with the patient in the lateral decubitus position under general hypotensive anesthesia. There were no significant differences in the surgical technique between two surgeons. Only the first author performed open rotator cuff repair for massive rotator cuff tears according to the tear size and tendon retraction.

Range of motion (forward flexion, internal rotation, and external rotation), visual analog scale (VAS) score for pain and satisfaction, the American Shoulder and Elbow Surgeons (ASES) score, simple shoulder test (SST) score, and Constant-Murley score were determined to assess functional outcomes. In each hospital, the range of motion and clinical scores were evaluated by an independent clinical researcher who was blind to the current study.

In 12 of the total 16 patients, MRI or ultrasonography (USG) was used to assess the continuity of the repaired tendons at least 6 months after surgery. The integrity of the repair was analyzed by MRI or USG performed by a radiologist with special training in musculoskeletal radiology in each hospital. On MRI, according to the Sugaya classification (type I, sufficient thickness with homogeneously low intensity on each image; type II, sufficient thickness, partial high-intensity area; type III, less than half the thickness without discontinuity; type IV, minor discontinuity; and type V, major discontinuity), types IV and V were regarded as healing failure.[11] USG criteria for the diagnosis of a retear were as follows: nonobservation of the repaired tendon attributable to retraction, focal defect, or gap within the repaired tendon with consecutive loss of the normal anterior arc of the subdeltoid bursa; loss of the repaired supraspinatus substance with widening of the gap between the supraspinatus and biceps tendon; and hypoechoic or anechoic cleft extending through the entire substance of the repaired cuff.[12-14]

Statistical analysis was performed using SPSS ver. 18 (SPSS Inc., Chicago, IL, USA). The Wilcoxon signed-rank test for preoperative and postoperative comparisons of the range of motion and clinical scores were performed. The threshold for statistical significance was $p < 0.05$.

RESULTS

The study ultimately included 16 patients (9 men and 7 women), and their mean age was 57.1 years (range, 45 to 71 years). Rotator cuff tear developed in the dominant arm in 87.5% of patients: the dominant hand was involved in 14 patients, and the nondominant hand in 2. The mean follow-up duration was 18 months (range, 12 to 38 months). Arthroscopic rotator cuff repair was performed in 13 patients, and open rotator cuff repair in 3.

The comorbid disability conditions were as follows: both lower extremities were affected in 4 patients; the

contralateral upper extremity was affected in 4 patients; the ipsilateral upper and lower extremities were affected in 3 patients; the contralateral upper and lower extremities were affected in 3 patients; the ipsilateral lower extremity was affected in 1 patient; and the contralateral lower extremity was affected in 1 patient (Table 1). The initial causes of comorbid disability conditions were as follows: poliomyelitis in 5 patients; amputation due to infection or trauma in 4; spinal cord injury in 2; intracranial hemorrhage in 2; and cerebral infarction in 3. Eight patients walked with crutches, and the other 8 patients did not. We assessed the functional mobility scale (FMS) at 500 m in these patients: the FMS rating was 3 in 4 patients, 4 in 4 patients, 5 in 5 patients, and 6 in 6 patients (Table 2).[15] Intraoperative tear size measurement indicated 1 small, 9 medium-sized, 6 large-to-massive tears. Large-to-massive tears were found in 4 of 8 crutch users and in 2 of 8 non-crutch users (Table 3).

Range of motion improved after surgery at the final follow-up visit (Table 4); flexion increased from 134° (range, 85° to 170°) to 160° (range, 110° to 180°; $p = 0.015$), internal rotation increased from T12 (L5-T7) to T10 (L5-T5; $p = 0.136$), and external rotation increased from 45° (range, 10° to 60°) to 67° (range, 30° to 90°; $p = 0.018$).

All functional outcomes also improved significantly at the final visit (Table 5). Pain VAS improved from 7 points (range, 4.5 to 9 points) to 1 point (range, 0 to 3 points; $p < 0.001$), and ASES scores improved from 44 points (range, 18 to 58 points) to 89 points (range, 65 to 100 points; $p = 0.001$). SST scores improved from 5 points (range, 0 to 9 points) to 10 points (range, 8 to 12 points; $p = 0.003$), and Constant-Murley scores improved from 47 points (range, 19 to 61 points) to 82 points (range, 57 to 100 points; $p = 0.002$).

The integrity of the repair was analyzed by MRI or USG performed by a radiologist with special training in musculoskeletal radiology in each hospital. On MRI, according to the Sugaya classification (type I, sufficient thickness with homogeneously low intensity on each image; type II, sufficient thickness, partial high-intensity area; type III, less than half the thickness without discontinuity; type IV, minor discontinuity; and type V, major discontinuity), types IV and V were regarded as healing

Table 1. Comorbid Conditions

Comorbid condition	Affected limb	Case
Paralysis	Ipsilateral lower extremity	1
	Both lower extremities	4
	Contralateral upper & lower extremities	1
Weakness	Contralateral lower extremity	1
	Ipsilateral upper & lower extremities	4
	Contralateral upper & lower extremities	1
Amputation	Contralateral upper extremity	3
Mixed	Contralateral lower extremity amputation & contralateral upper extremity paralysis	1

Table 3. Tear Size, Use of Crutches and Retear*

Tear size	Crutch walker (retear)	Non-crutch walker (retear)
Massive tear	3 (1)	2
Large tear	1 (1)	-
Medium tear	3 (1)	6 (1)
Small tear	1	-

*All retears involved dominant side.

Table 2. The Functional Mobility Scale (FMS) at 500 m

FMS 500 rating	Case
1. Uses wheelchair, stroller or buggy: may stand for transfers and may do some stepping supported by another person or using a walker/frame.	-
2. Uses Kaye Walker or other walking frame: without help from another person.	-
3. Uses two crutches: without help from another person.	4
4. Uses one crutch or two sticks: without help from another person.	4
5. Independent on level surfaces: does not use walking aids or need help from another person. If uses furniture, walls, fences, shop fronts for support please use 4 as the appropriate description.	5
6. Independent on all surfaces: does not use any walking aids or need any help from another person when walking, running, climbing, and climbing stairs.	3

Table 4. Comparison of Ranges of Shoulder Motion

Range of motion	Preoperative	Postoperative	*p*-value
Forward flexion (°)	134 (85–170)	160 (110–180)	0.015
Internal rotation (vertebral levels)	T12 (L5–T7)	T10 (L5–T5)	0.136
External rotation (°)	45 (10–60)	67 (30–90)	0.018

Values are presented as mean (range).
T: thoracic, L: lumbar.

Table 5. Comparison of Functional Scores

Variable	Preoperative	Postoperative	*p*-value
Pain VAS	7 (4.5–9.0)	1 (0–3)	< 0.001
Satisfaction VAS	-	9 (6–10)	-
ASES score	44 (18–58)	89 (65–100)	0.001
SST score	5 (0–9)	10 (8–12)	0.003
Constant-Murley score	47 (19–61)	81 (57–100)	0.002

Values are presented as mean (range).
VAS: visual analog scale, ASES: American Shoulder and Elbow Surgeons, SST: simple shoulder test.

failure.[11] For USG, criteria for the diagnosis of a retear were as follows: nonobservation of the repaired tendon attributable to retraction, focal defect, or gap within the repaired tendon with consecutive loss of the normal anterior arc of the subdeltoid bursa; loss of the repaired supraspinatus substance with widening of the gap between the supraspinatus and biceps tendon; and hypoechoic or anechoic cleft extending through the entire substance of the repaired cuff.[12-14] The structural integrity of the repair was maintained in 8 patients, whereas healing failure was observed in 4 patients. Two healing failures occurred in patients who walked with crutches and had comorbid disability in both lower extremities; one had a massive rotator cuff tear and the other had a large tear. The other 2 healing failures occurred in patients with medium-sized tears; one walked with crutches and had comorbid disability in the contralateral upper and lower extremities, and the other had contralateral upper extremity disability. Three of 4 healing failures occurred in crutch users, and all of them involved the dominant side (Table 3). The mean follow-up duration in retear patients was 20.8 months (range, 12 to 35 months). Their function was sufficiently good, so revision surgery was not needed until the last follow-up. Patients with retear are regularly followed and the size of retear has been stationary.

DISCUSSION

The important findings of this investigation were as follows: (1) the tear size in crutch users tended to be larger than that in non-crutch users; (2) the outcomes of rotator cuff repair in patients with comorbid disability in other extremities were satisfactory in terms of function and healing in 8 of 12 shoulders; and (3) structural healing failure was more common in crutch users (3 of 4 healing failures).

Rotator cuff tear in the general population is an age-related, degenerative condition with a significantly higher incidence among elderly patients.[16,17] However, in paraplegic patients, the biomechanical conditions of the shoulders adapt to their specialized activities of daily life. Most of these patients experience shoulder pain while performing activities of daily life, especially during weight-bearing tasks such as transfers, wheelchair propulsion, and weight-relief raises.[6,9] Joint reaction forces during these tasks are greater in paraplegic patients than in the able-bodied population and may ultimately lead to disabling shoulder pain and functional disorders with subsequent loss of independence.[1] For these reasons, the occurrence of rotator cuff tears depends on the duration of wheelchair dependency as well as age.[18] These stresses on the shoulder joint during daily activities also occur in patients with comorbid disabilities in the extremities.

In the current study, rotator cuff tear developed in the dominant arm in 87.5% of patients, and large to massive tears were found more frequently in crutch users (4/8) than in non-crutch users (2/8). The tear size in crutch users tended to be larger than that in non-crutch users. These findings support the theory of "wear and tear" and emphasize the importance of early diagnosis of rotator cuff tear in patients who use crutches or wheelchairs. Pentland and Twomey[6] reported that only 10% of patients with paraplegia received surgical treatment for shoulder pain because they were concerned about the invasiveness of the surgery and the inability to perform activities of daily living during the recovery period. Most of these patients rely on conservative treatments, such as medication, physical therapy, and manual therapy. However, considering the natural history of rotator cuff tear, the longer the patient with a reparable tear relies on conservative treatment, the greater the chance of fatty degeneration of the rotator cuff muscles, which is critical for repair and recovery after surgery.

Surgeons also face challenging decisions about the use of surgical treatment because of the high physical demand on the shoulders of the paraplegics and the increased incidence of degenerative changes resulting from the use of wheelchairs or crutches. These changes raise questions regarding the repair and subsequent rehabilitation and recovery processes. Goldstein et al.[4] reported poor clinical outcomes after rotator cuff surgery in patients with paraplegia, with failure of the repaired cuff in 5 of 6 shoulders and satisfactory outcome in only 1. The authors identified smoking, poor baseline passive range of motion, and supraspinatus and infraspinatus muscle atrophy as the factors resulting in poor outcomes after surgical management. However, other small case series of disabled patients who underwent rotator cuff surgery have reported favorable clinical results.[7,8,10] Hanada et al.[7] reported retear in 1 of 4 shoulders (2 moderate and 2 large rotator cuff tears). Popowitz et al.[10] reported that 7 of 8 shoulders returned to their preinjury level of function, and all patients felt that they would recommend the procedure to other spinal cord injury patients. Jung et al.[8] reported retears in 2 of 16 shoulders of wheelchair-bound paraplegic patients, both in patients with massive tears, but their functional scores improved over time. In their study, patients were strongly advised not to use the affected arm for strenuous activity, such as leaning or wheelchair pushing and propulsion, for 6 months. In the present study, independent transfers and manual wheelchair use were permitted 10 weeks after surgery. The current study demonstrated satisfactory functional and anatomical outcomes in 8 of 12 shoulders. Although healing failure was detected in 1 massive, 1 large, and 2 medium-sized tears, none of these cases required revision surgery. Therefore, rotator cuff repair in patients with comorbid disabilities resulted in less pain and improved function, and helped to maintain patients' performance of independent activities. Even though it is the beyond the scope of the current study, authors carefully suggest early diagnosis will help to detect a smaller tear, and thereby timely intervention will increase the healing rate and be able to avoid the complications of chronic rotator cuff tear after surgical repair, especially in crutch users with dominant arm involvement.

Furthermore, rehabilitation in patients with comorbid disability requires special care. In the present study, 3 of 4 healing failures occurred in crutch users, and all 4 retears involved the dominant side. Even though all patients were advised to use electric wheelchairs and perform only assisted transfers for the first 8 weeks, with independent transfers and manual wheelchair use permitted after 10 weeks, overuse of the repaired shoulder might have been somewhat inevitable. However, considering the importance of the repaired shoulder to perform activities of daily living, it may be more appropriate to suggest long-term and rigid rehabilitation in patients who use crutches and those with tears in the dominant shoulder. Surgeons should explain the importance of rehabilitation in detail to patients, guardians, and other supporters.

This study has some limitations. First, it included a small number of patients with heterogeneous premorbid conditions. Since patients with comorbid disability were rare, we combined data obtained from 2 different surgeons at 2 separate tertiary institutions. Another limitation is the short-term assessment of tendon integrity, which was performed at least 6 months after surgery by MRI or USG. Kim et al.[19] and Kluger et al.[20] reported that retears occurred infrequently in the late postoperative period (from 3 months after surgery). Codsi et al.[21] and Prickett et al.[22] also reported that ultrasound may be used to evaluate the integrity of a repaired rotator cuff tendon and constitutes a comparable alternative to MRI when evaluating the integrity of rotator cuff repair. Therefore, we think that the assessment of short-term results at least 6 months after surgery by USG had little effect on the anatomical results. Studies involving a longer follow-up and a larger sample size would further improve our understanding of outcomes after rotator cuff repair in this patient population.

In conclusion, shoulder function in patients with comorbid disability in other extremities is indispensable for activities of daily living; therefore, rotator cuff repair may be an excellent option when a tear is diagnosed. The

outcomes of rotator cuff repair in patients with comorbid disability in other extremities were favorable. Careful planning and rehabilitation is particularly more important for crutch users and in cases of dominant arm involvement in disabled patients.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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