Cutoff value of Japanese Orthopaedic Association Shoulder Score in Patients with Rotator Cuff Repair: Based on the University of California at Los Angeles Shoulder Score

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Ethical disclosure

The Institutional Review Board of Kurume University approved the study protocol (#15122), and all subjects gave their informed consent for participation in the study.
Abstract

Background: The Japanese Orthopaedic Association shoulder score cutoff values were calculated in patients with rotator cuff repair using the University of California at Los Angeles shoulder score.

Methods: Overall, 175 patients with rotator cuff repair were subjects in this study. The University of California at Los Angeles and Japanese Orthopaedic Association shoulder scores were evaluated before surgery and at 3, 6, 9, and 12 months after surgery. The cutoff value of the Japanese Orthopaedic Association shoulder score was determined using the 4-stage criteria of the University of California at Los Angeles shoulder score and a University of California at Los Angeles shoulder score of 28 points, which is the boundary between an excellent/good group and a fair/poor group.

Results: Both the JOA shoulder and UCLA shoulder scores showed significant improvement at 6, 9, and 12 months from the preoperative scores (p < 0.0001). There was a strong correlation between the total values of the two scores (r = 0.85, p < 0.0001). The cutoff value of the Japanese Orthopaedic Association shoulder score based on the highest accuracy from receiver operating characteristic curve analysis was 83 points.

Conclusion: A Japanese Orthopaedic Association shoulder score cutoff value of 83 was equivalent to a University of California at Los Angeles shoulder score cutoff value of 28 for distinguishing between excellent/good and fair/poor outcomes after rotator cuff repair.
Introduction

Rotator cuff tears commonly occur in middle-aged and elderly persons [1]. Intrinsic (tendon degeneration [2]) and/or extrinsic (subacromial impingement [3]) factors are associated with the development of the disease. Conservative therapies [4], such as administration of non-steroidal anti-inflammatory drugs, intra-articular injections [5], and physiotherapy [6], are usually selected; however, rotator cuff repair is performed when preoperative treatment fails [7].

The Japanese Orthopaedic Association (JOA) shoulder score, which has been used to evaluate shoulder function, consists of pain (30 points), functions (general functions, 10 points; daily activities, 10 points), range of motion (active movement, 30 points), X-ray findings (5 points), and joint stability (15 points) for a total of 100 points [8]. In patients who undergo rotator cuff repair, the JOA shoulder score is often used to assess the preoperative status and postoperative clinical outcome or to assess outcomes after different procedures in these patients in Japan [8-13, 20, 21]. In those evaluated by the JOA shoulder score, \( \geq 81 \) points after surgery is reported to be satisfactory and \( \leq 80 \) points before surgery is clinically unsatisfactory [8,9,20,21]. However, no suitable evidence to support the cutoff value described above has been reported.

The University of California at Los Angeles (UCLA) shoulder score was designed to evaluate the postoperative results for shoulder arthroplasty [14], and the revised edition is used to evaluate operative results for rotator cuff tear [5, 16]. The UCLA shoulder score consists of pain (10 points), functions (10 points), range of motion in the joint (5 points), manual muscle test (5 points), and patient satisfaction level (5 points) for a total of 35 points [15]. The following outcome criteria are used: Excellent, \( \geq 34 \) points; Good, 28 to 33 points; Fair, 21 to 27 points; and Poor, \( \leq 20 \) points [15]. Since excellent/good is considered satisfactory and fair/poor is considered unsatisfactory, the UCLA shoulder score cutoff value has been set to 28. At present, the UCLA shoulder scoring system is used worldwide and shows good correlation with clinical outcome in patients who have undergone rotator cuff repair [17, 18]. Therefore, the purpose of the present study was to determine the JOA shoulder score cutoff value for distinguishing between excellent/good and fair/poor outcomes after rotator cuff repair.
rotator cuff repair by using the UCLA shoulder score as a standard reference.

**Materials and Method**

The Institutional Review Board of Kurume University approved the study protocol (approval number 15122) and all subjects gave their informed consent for participation in the study.

**Subjects**

Between January 2002 and December 2013, 342 patients with rotator cuff tear underwent open or arthroscopic surgery in our institution. The following inclusion criteria were used: (1) individuals who had complete cuff tear received open or arthroscopic surgery and (2) individuals who followed strict rehabilitation for at least one year after surgery. The following exclusion criteria were used: (1) individuals who had no evaluation by either the UCLA shoulder score or JOA shoulder score, (2) individuals who had partial tear and (3) individuals who had fractures involving the shoulder, progressive arthritis, osteoarthritis, or infection. On the basis of these criteria, 175 patients (19 with small tears, 42 with moderate tears, 75 with large tears, and 39 with massive tears [19]) were included as subjects in this study.

Of the 175 patients, arthroscopic surgery was performed in 114 patients and open surgery was performed in 61 patients. There were 105 males and 70 females, with a mean age of 62.1 ± 8.7 years. The mean period from onset to surgery was 9.3 ± 10.2 months. There were 18 patients with diabetes, 51 patients with shoulder contracture who had manual manipulation and / or arthroscopic capsular release during surgery, and 114 patients with apparent traumatic history. Details are shown in Table 1.

**Data collection**

To evaluate the functional outcome, the JOA and UCLA shoulder scores were determined before surgery and at 3, 6, 9, and 12 months after surgery. The data were obtained by a physical therapist in charge who was
blind to this study throughout the periods. The physical therapists had an average experience of 10.4 ± 3.4 years.

Surgical procedure

The operations were performed under general anesthesia in a beach chair position. Open surgery was performed in 61 cases using the McLaughlin method in which the tendon stump of the torn rotator cuff was re-attached into the bone trough on the greater or lesser tuberosities. Arthroscopic surgery was performed in 114 cases by using the single-row or suture bridge method. Open or arthroscopic subacromial decompression (ASD) was performed in all patients followed by immobilization with an abduction pillow.

Postoperative rehabilitation

Elbow, wrist, and finger range of motion exercises were started immediately after surgery. At four days after surgery, passive range-of-motion exercise was started. At seven weeks after surgery, active exercise and isometric strength training were permitted. Isotonic muscle strength training was begun eight weeks after surgery.

Statistical analysis

Statistical analysis was performed by using IBM® SPSS® Statistics 22.0(IBM Inc., Armonk, NY, USA), JMP®11 and SAS® 9.4 (SAS Institute Inc., Cary, NC, USA).

The Friedman test and Steel–Dwass test was used to compare the scores before the operation and those at 3, 6, 9, and 12 months after surgery.

To evaluate the relationship between the JOA shoulder score and the UCLA shoulder score, we employed the mixed-effect models since the JOA shoulder score and the UCLA shoulder score were obtained several times from each patient. The Mixed Model contains two model parameters, intercept and slope, and the relationship between the JOA shoulder score and UCLA shoulder score was evaluated by the estimated slope.
as well as correlation coefficient defined as square-root of the total explained variance ($R^2$). In addition, we
similarly examined the relationship of the following four sub-items: (1) pain, (2) activities of daily living, (3)
range of motion (active motion), and (4) general functions of the JOA shoulder score and (1) pain, (2) function,
(3) active forward flexion, and (4) strength of forward flexion the UCLA shoulder score.

Next, we derived the cutoff value of the JOA shoulder score. To this end, all patients were classified into two
groups (excellent / good, fair / poor) based on the reported cutoff value of the UCLA shoulder score. Then,
receiver operating characteristic (ROC) curve analysis was performed to obtain the cutoff value for the JOA
shoulder score using random-effect logistic model which accounts for serial correlation between
repeated-measurement of the JOA and the UCLA shoulder scores from each patient. A p value of <0.05 was
taken as indicating a statistically significant difference.

Results

The total JOA shoulder scores before and at 3, 6, 9, and 12 months after surgery were 62.7 ± 10.8, 77.3 ±
10.8, 84.3 ± 9.6, 87.5 ± 9.0, and 88.5 ± 8.8 points, respectively, and the total UCLA shoulder scores were 14.3 ±
5.9, 22.3 ± 5.4, 28.4 ± 3.4, 28.7 ± 3.9, and 29.2 ± 4.5 points, respectively. Both the JOA shoulder and UCLA
shoulder scores showed significant improvement at 6, 9, and 12 months from the preoperative scores (p <
0.0001) (Figure 1).

There were significant correlations between the UCLA and JOA shoulder scores as shown by the following
results: total JOA / UCLA shoulder scores ($r = 0.85$, p < 0.0001), JOA / UCLA shoulder “Pain” scores ($r = 0.81$,
p < 0.0001), JOA shoulder “Activities of daily living” score and UCLA shoulder “Function” score ($r = 0.77$, p
< 0.0001), JOA shoulder “Range of motion” score and UCLA shoulder “Active forward Flexion” score ($r =
0.89$, p < 0.0001), and JOA shoulder “General Functions” score and UCLA shoulder “Strength of forward
flexion” score ($r = 0.80$, p < 0.0001) (Table 3).

Because the cutoff value between “Satisfactory” and “Unsatisfactory” is set at 28 points in the UCLA
shoulder score, we next calculated the cutoff value in the JOA shoulder score that is equivalent to 28 points in the UCLA shoulder score, using ROC curve after logistic regression analysis. The JOA shoulder score based on the ROC curve analysis after logistic regression analysis that was equivalent to the UCLA shoulder score cutoff value of 28 was 83 (area under the curve: AUC = 0.94, sensitivity = 91.8%, specificity = 84.1%) (Figure 2).

**Discussion**

In Japan, the JOA shoulder score has been used for postoperative evaluation of rotator cuff tear; however, no standard cutoff value for differentiating between outcomes has been established. The present study evaluated both the JOA and UCLA shoulder scores before and after surgery in the same patients and calculated the JOA shoulder score cutoff value by using the UCLA shoulder score as a basic standard. Ellman and Kay [15] classified the UCLA shoulder score (total of 35) into four grades: Excellent (≥34), Good (28–33), Fair (21–27), and Poor (≤20). Excellent / good is considered satisfactory and fair / poor is considered unsatisfactory. Therefore, in the present study, the UCLA shoulder score of 28 was set as the cutoff value to differentiate between excellent / good and fair / poor outcomes after rotator cuff repair, and the equivalent JOA shoulder score cutoff value was determined to be 83.

The UCLA shoulder score is considered to be a useful tool for evaluation of rotator cuff tears [3, 15, 16]. Ide *et al.* [8, 12] used the UCLA and JOA shoulder scores for clinical evaluation of patients with mini-open or arthroscopic cuff repair. In their study, preoperative / postoperative results were significantly improved, and there was no statistical difference between the procedures [8]. When using UCLA shoulder scores to evaluate outcomes in patients with rotator cuff repair, a mean JOA shoulder score of 89.3 points corresponded to a 91% satisfaction level in the UCLA shoulder score [13]. Other studies have also used either the JOA, UCLA, or both shoulder scores to evaluate clinical outcomes after rotator cuff repair [8-13, 15, 20, 21]. Thus, both scores have been widely used for clinical evaluation of postoperative rotator cuff tear.
For the UCLA shoulder score, a total score of $\geq 80\%$ (28/35 = 0.8) is defined as excellent/good [15]. Ide et al. [8] used the grading system of the JOA shoulder score; the outcome were deemed to be excellent, good, fair, and poor if the total scores were $> 90, 81 – 90, 71 – 80$, and $< 71$ points, respectively. In their report, excellent/good was defined as satisfactory and fair/poor as unsatisfactory. However, the JOA shoulder score cutoff value of 83 obtained in this study was associated with outcomes to those for the UCLA shoulder score of 28, after ROC curve analysis of our data. Thus, these results suggest that not only the UCLA shoulder score but also the JOA shoulder score is a useful grading system for patients with rotator cuff repair.

There were some limitations in this study. First, this was a retrospective study. Second, the follow-up period in the present study was relatively short (one year after surgery); therefore, the clinical outcome was not simply comparable with those in the other studies. Third, to calculate the JOA shoulder score cutoff value, only the UCLA shoulder score was used as a basic standard. Referencing to other scores may have changed our results. In the Constant score that is widely used, a cutoff value has also been designated, and studies using this score are currently underway. Fourth, the apparent rationale about how the cutoff value between “Satisfactory” and “Unsatisfactory” was set was not reported in the UCLA shoulder score. However, the JOA shoulder score cutoff value of 83 was equivalent to the UCLA score cutoff value of 28 based on the ROC curve analysis.

**Conclusion**

A JOA shoulder score cutoff value of 83 was equivalent to a UCLA shoulder score cutoff of 28 for differentiating between acceptable and unacceptable postoperative outcomes in patients after rotator cuff repair.
References


Table 1. Patient demographics

<table>
<thead>
<tr>
<th></th>
<th>All patients</th>
<th>Arthroscopic surgery</th>
<th>Open surgery</th>
</tr>
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<tbody>
<tr>
<td>Age (y)</td>
<td>62.1 ± 8.7</td>
<td>62.6 ± 9.2</td>
<td>61.2 ± 7.6</td>
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<tr>
<td>Sex Male / Female (n)</td>
<td>105 / 70</td>
<td>63 / 51</td>
<td>42 / 19</td>
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<tr>
<td>Diabetes (n)</td>
<td>18</td>
<td>11</td>
<td>7</td>
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<tr>
<td>Preoperative Contracture (n)</td>
<td>51</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>History of trauma (n)</td>
<td>114</td>
<td>68</td>
<td>46</td>
</tr>
<tr>
<td>Duration of symptoms (w)</td>
<td>7.7 ± 8.9</td>
<td>7.7 ± 8.4</td>
<td>7.8 ± 9.9</td>
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</tbody>
</table>
Table 2. Tear size and operative procedures

<table>
<thead>
<tr>
<th>Tear Size</th>
<th>All patients</th>
<th>Arthroscopic surgery</th>
<th>Open surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>19</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Moderate</td>
<td>42</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>Large</td>
<td>75</td>
<td>51</td>
<td>24</td>
</tr>
<tr>
<td>Massive</td>
<td>39</td>
<td>21</td>
<td>18</td>
</tr>
</tbody>
</table>

Surgical procedure (n)
- Suture bridge / single row: 69 / 45, 69 / 45, -
- McLaughlin: 61, -, 61

Treatment of biceps (n)
- Tenotomy: 44, 40, 4
- Tenodesis: 12, 5, 7
- No treatment: 119, 69, 50

*a DeOrio & Cofield cuff tear size classification [19]*
<table>
<thead>
<tr>
<th>JOA shoulder score</th>
<th>UCLA shoulder score</th>
<th>r</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Total score</td>
<td>Total score</td>
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<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pain</td>
<td>Pain</td>
<td>0.81</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ADL</td>
<td>Function</td>
<td>0.77</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ROM</td>
<td>Active forward flexion</td>
<td>0.89</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>General Functions</td>
<td>Strength of forward flexion</td>
<td>0.80</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

JOA shoulder score = Japanese Orthopaedic Association shoulder score, UCLA shoulder score = University of California at Los Angeles shoulder score, ADL = Activity of daily living, ROM = Range of motion, r = Correlation coefficient
Preoperative and postoperative clinical course associated with the JOA shoulder score and UCLA shoulder score.

Preoperative JOA and UCLA shoulder scores showed significant improvement at 6, 9, and 12 months (p < 0.0001, respectively)

B.O., before operation; P.O., post-operation; M, months; JOA shoulder score, Japanese Orthopedic Association shoulder score; UCLA shoulder score, University of California at Los Angeles shoulder score.

Receiver operating characteristic curve for determining surgical outcomes by postoperative JOA shoulder score.

ROC curve analysis after logistic regression analysis demonstrated that 83 points of the JOA shoulder score was equivalent to 28 points as a cutoff value in the UCLA shoulder scoring system (AUC = 0.94, sensitivity = 91.8%, specificity = 84.1%)

JOA shoulder score, Japanese Orthopedic Association shoulder score; AUC, area under the curve.
Figure 1.

Figure 2.

Cutoff value 83.0 points
Sensitivity 91.8%
Specificity 84.1%

AUC 0.94