Clinical Follow-up of Professional Baseball Players Undergoing Ulnar Collateral Ligament Reconstruction Using the New Kerlan-Jobe Orthopaedic Clinic Overhead Athlete Shoulder and Elbow Score (KJOC Score)

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Background: There are no validated outcome measures consistently used in the literature to report results of ulnar collateral ligament reconstruction in overhead athletes.

Hypothesis: The Kerlan-Jobe Orthopaedic Clinic Overhead Athlete Shoulder and Elbow score (KJOC score) will correlate with other validated scores for upper extremity assessment but will be more accurate in evaluating ulnar collateral ligament reconstruction outcomes in professional baseball players.

Study Design: Cohort study (diagnosis); Level of evidence, 2.

Methods: Fifty-five professional baseball players who underwent ulnar collateral ligament reconstruction were asked to complete the KJOC score, the Disabilities of the Arm, Shoulder and Hand (DASH) score, and the DASH sports module. Players were separated into 3 categories—(1) playing without pain, (2) playing with pain, and (3) not playing because of pain—and compared with 123 asymptomatic throwers. Pearson (parametric) and Spearman rank (nonparametric) correlations among the 3 systems were conducted to validate the KJOC score. Means across categories were compared using a Wilcoxon rank-sum test, and a threshold score separating categories 1 and 3 was determined using receiver operator characteristic discrimination analysis.

Results: Significant correlations were found between the KJOC score and the DASH ($-.693$, $P < .0001$), and the DASH sports module (-0.804, $P < .0001$). Only the KJOC score was able to discriminate between categories 2 and 3, as well as category 1 and the uninjured population. In addition, the KJOC score was the most sensitive and accurate method of discriminating category 1 from category 3, with a threshold score of 81.3.

Conclusion: The results of this study validate the use of the KJOC score for evaluation of overhead athletes undergoing ulnar collateral ligament reconstruction. The KJOC score is the most sensitive score for detecting subtle changes in performance in the throwing athlete.

Keywords: baseball; elbow; ulnar; medial

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Improvements in both diagnosis and surgical technique have led to a dramatic increase in the number of ulnar collateral ligament (UCL) reconstructions performed each year.[30] Originally described by Jobe et al[17] in 1974, the surgery involves reconstruction of the anterior oblique band of the UCL with use of an autologous free tendon graft.[17,30] Restoration of this structure allows high-level overhead athletes to return to the sporting activities that

place near maximal loads on the medial structures of the elbow.[4,16,25]

One of the most important aspects of evaluating any surgery is to establish a reproducible way to assess the outcome of the procedure. A standardized outcome measure allows for defining success or failure of a procedure as well as for accurate comparison of surgical outcomes performed by different surgeons at different institutions. With respect to UCL reconstruction, there are no validated outcome instruments consistently reported in the literature. In 1992 Conway et al[8] identified the ability of the athlete to return to previous or higher level of competition as the ultimate tool for measuring the success of UCL reconstruction. Athletes are rated as excellent, good, fair, or poor based on return to level of competition and activity for at least 12 months. Various authors have used this outcome measure to report the results of their UCL reconstructions.[2,23,25,27,30]

Although return to competition is an important outcome measure for overhead athletes after surgery, this standard does not account for subtle performance changes such as endurance limitations, loss of velocity/power, or control problems. The Kerlan-Jobe Orthopaedic Clinic Overhead Athlete Shoulder and Elbow score (KJOC score) is a validated functional assessment tool.[1] It is an efficient, patient-administered questionnaire that reliably measures the functional status of the upper extremity in the overhead athlete. This study reports the results of UCL reconstruction in professional baseball players using the KJOC score as an assessment tool, and compares the KJOC score with other validated outcome measurement tools for the upper extremity. The purpose of this study is to establish the KJOC score as one of the standards for measuring outcomes of surgical reconstruction of the UCL in overhead athletes, who place specialized stress on their elbows compared with the normal population.[12] This type of measurement tool is necessary considering the volume of research conducted on UCL reconstruction as several recent articles have reported studies of UCL reconstruction in the high-demand athlete population.[9,10,13,24,25,30,31] In addition, current biomechanical studies of variation on UCL reconstruction technique will eventually require clinical follow-up studies to bridge the gap between the laboratory and the playing field.[6,7,15,19,21]

MATERIALS AND METHODS

Between Major League Baseball spring training in March 2006 and spring training in March 2007, 55 professional baseball players who had undergone UCL reconstruction completed 3 postsurgical outcome measure questionnaires: the KJOC score, the Disabilities of the Arm, Shoulder and Hand (DASH) score, and the DASH sports module. The DASH and DASH sports module scores were selected because they are validated and reliable outcome measures that have been previously used to report surgical outcomes in the upper extremity.[3,5,14] Fifty-five subjects completed the KJOC score and the DASH, and 51 of the 55 subjects completed the DASH sports module as well. These 55 subjects were divided into 3 injury categories for comparison and were also compared with a population of 123 asymptomatic "normal" throwers, players who had not sustained an injury. All 123 uninjured throwers completed the KJOC score, 84 completed the DASH score, and 75 completed the DASH sports module.

Patient Demographics

The average age of the players was 25.4 years (range, 20-41; standard deviation [SD], 4.1). There were 50 pitchers, 4 catchers, and 1 infielder in the study group. All 55 throwers were male; 45 players were right-handed and 10 players were left-handed. There were 13 subjects playing at the major league level, 41 at the minor league level, and 1 player was in independent league baseball. Average time from surgery was 38.2 months (range, 12-92; SD, 21.4); 17 players were between 12 and 24 months from surgery and 32 players were more than 24 months from surgery. Six players had elbow surgeries before the most recent UCL reconstruction; 3 had prior UCL reconstructions, 2 had an ulnar nerve transposition, and 1 had both a prior UCL reconstruction and an ulnar nerve transposition. One player had a medial antebrachial cutaneous neurolysis after his UCL reconstruction but was back to full competition at the major league level at the time he completed the questionnaires.

The control group of 123 asymptomatic, uninjured overhead athletes had similar demographic information. The population consisted of 114 men, 98 right-handed subjects, 102 baseball players, with 92 of those players in either the major or minor leagues. The mean age was 23.8 (SD 4.1) years, and these patients had played their sport for an average of 5.9 years.

Scoring Models

The KJOC score consists of a demographics sheet followed by a 10-item subjective questionnaire (see online Appendix 1 for this article at http://ajs.sagepub.com/supplemental/). As part of a collection of initial demographic information in the KJOC score, players categorize their current level of play in 1 of 3 ways: playing with no arm trouble (category 1), playing but with arm trouble (category 2), or not playing because of arm trouble (category 3). This information is not included in the player's KJOC score. The 10 question items are each geared toward the functional performance status of the upper extremity in the overhead athlete. All questions use a visual analog scale in which the patient marks a line between 0 and 10 cm. The mark is measured from the left to the nearest millimeter to obtain a numerical value for the question between 0 and 10 to the nearest tenth. The 10 questions give a total possible score of 100, with higher scores indicating higher function for all questions.

The DASH score consists of a 30-item questionnaire that is completed by the patient. It is focused on the pain and functional status of the upper extremity. There are no questions specifically addressing the elbow, and none of the questions address performance in sports activities. The score is calculated based on a formula previously described with a best possible score of 0 and a worst possible score of 100.[14]

The DASH sports module is a 4-item questionnaire that is completed by the patient and specifically addresses the function of the affected upper extremity in sports activities. The score is calculated with a formula similar to that of the DASH score, with 0 representing the best score and 100 the worst score.[3,14]

Statistical Methods

Validity Assessment. Pearson (parametric) and Spearman rank (nonparametric) correlations among the 3 scoring systems were computed for all 55 injured players and 123 uninjured players to assess validity. Probability values for comparing the correlations to each other were calculated using the methods given by Kleinbaum et al.[18]

Score Comparisons. The DASH and DASH sports module scores were standardized by subtracting each score from 100 so that the "worst" score was 0 and the "best" score was 100, consistent with the KJOC score direction. The *P* values for comparing scores between groups (cross-category) were computed using the Wilcoxon rank-sum test. A nonparametric method was used because the data distributions did not follow a Gaussian (normal) distribution.

Discrimination. Lastly, a threshold value to separate category 1 (playing without pain) from category 3 (not playing because of pain) was determined using receiver operator characteristic (ROC) discrimination analysis. The ROC threshold is chosen such that the classification accuracy is maximized, where accuracy is the unweighted average of sensitivity and specificity.

All analyses were performed by a trained statistician using JMP statistical software, version 5.1 (JMP, SAS Inc, Cary, North Carolina) and SAS version 9.2.

RESULTS

Overall, 55 patients completed the KJOC score and DASH questionnaires and 51 patients completed the DASH sports module. Of the 55 subjects, 41 identified themselves as category 1 (playing without pain), 4 identified themselves as category 2 (playing with pain), and 10 identified themselves as category 3 (not playing because of pain). The Pearson and Spearman correlations are presented in Table 1. All correlations were significantly different from zero at $P < .01$ or smaller. The KJOC score for the study group significantly correlated with the DASH and DASH sports module scores. The correlation was higher for the KJOC score and the DASH sports module than for the KJOC score and DASH (Pearson: KJOC and DASH sports module = −.8205, KJOC and DASH = −.6433, $P = .00163$; Spearman: KJOC and DASH sports module = −.8036, KJOC and DASH = −.6933, $P = .0208$). When adding the control group to the validation assessment, the Pearson correlations remained significantly different (KJOC and DASH sports module = −.8093, KJOC and DASH = −.6524, $P < .0001$), but the Spearman correlations were not significantly different for the KJOC and DASH sports module compared with the KJOC and DASH (KJOC and DASH sports module = −.5940, KJOC and DASH = −.5510, $P = .4366$).

TABLE 1
Kerlan-Jobe Orthopaedic Clinic Overhead Athlete Shoulder and Elbow (KJOC) Score Validation[a]

Group	Variable	By Variable	N	Pearson Correlation	Spearman Correlation
Injured	DASH score	KJOC	55	−0.643	−0.693
Injured	DASH sports module score	KJOC	51[b]	−0.821	−0.804
Uninjured	DASH score	KJOC	84[b]	−0.652	−0.551
Uninjured	DASH sports module score	KJOC	75[b]	−0.809	−0.594

[a]Pearson and Spearman correlations for the KJOC score and the Disabilities of the Arm, Shoulder and Hand (DASH), and the KJOC score and the DASH sports module.

[b]Four players did not complete the DASH sports module questionnaire; 84 of 123 uninjured subjects completed the DASH sports module; and 75 of 123 uninjured subjects completed the DASH sports module.

Table 2 shows the mean scores and their corresponding 95% confidence interval by category for each score standardized to a 100-point scale. The 123 asymptomatic throwers who had not sustained any injury are labeled "category 0."

Table 3 shows the *P* values for comparing the means in Table 2 across categories. In Table 3 all the questionnaires had significantly different means between players in category 1 (playing without pain) and 2 (playing with pain), and between categories 1 and 3 (not playing because of pain). However, only the KJOC score showed a difference beyond chance between categories 2 and 3, and category 1 and the uninjured population.

The ROC discrimination analysis revealed that a threshold score of 81.3 for the KJOC score discriminates between categories 1 and 3 with 100% sensitivity and 90.2% specificity. The unstandardized DASH score had a threshold score of 3.33, with only 90.0% sensitivity and 87.8% specificity. Even though the unstandardized DASH sports module showed 100% specificity with a threshold score of 37.5, the sensitivity was only 70%. Table 4 displays the sensitivity, specificity, and accuracy for all scores.

DISCUSSION

The ideal postsurgical outcome measurement tool would include a validated, reliable, and responsive scoring system that reports both subjective and objective data. The tool should also be easy to administer and relevant to the patient population.[29] In the case of an overhead athlete, this questionnaire would include information focused on the demands of the sport. Such a measuring tool does not currently exist for UCL reconstruction. One obstacle is that no reliable objective measurements exist for medial

TABLE 2
Report of the Means for Categories 0 through 4 for the Kerlan-Jobe Orthopaedic Clinic Overhead Athlete Shoulder and Elbow (KJOC) score and Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaires[a]

Category	N	KJOC	DASH	DASH Sports Module
0 (Uninjured players)	123	95.4 (93.8-97.0)	99.2 (98.8-99.6) n = 84[b]	98.8 (97.7-99.9) n = 75[b]
1 (Playing without arm pain)	41	90.4 (86.7-94.2)	99.0 (98.2-99.7)	97.0 (94.3-99.6) n = 39[b]
2 (Playing with arm pain)	4	73.5 (63.6-83.3)	90.1 (78.5-100)	62.5 (20.1-100)
3 (Not playing because of arm pain)	10	47.5 (35.8-59.3)	91.1 (86.0-96.1)	29.7 (3.73-55.7) n = 8[b]

[a]Standardized means with standard deviation; 95% confidence intervals are included in parentheses.
[b]Eighty-four of 123 control subjects completed the DASH and 75 of 123 control subjects completed the DASH sports module. All 123 controls completed the KJOC score. Thirty-nine of 41 category 1 and 8 of 10 category 2 patients completed the DASH sports module.

TABLE 3
Cross-category Wilcoxon Rank-Sum Test Results[a]

Comparison Categories	KJOC	DASH	DASH Sports Module
0 and 1	+ ($P = .0096$)	− ($P = .7469$)	− ($P = .4484$)
1 and 2	+ ($P < .0023$)	+ ($P < .0001$)	+ ($P < .0001$)
1 and 3	+ ($P < .0001$)	+ ($P < .0001$)	+ ($P < .0001$)
2 and 3	+ ($P = .0477$)	− ($P = .6083$)	− ($P = .2611$)

[a]An indication of which questionnaires produced statistically different means for each category. Only the Kerlan-Jobe Orthopaedic Clinic Overhead Athlete Shoulder and Elbow (KJOC) score was able to discriminate between categories 0 and 1 and between categories 2 and 3. DASH, Disabilities of the Arm, Shoulder and Hand; +, the difference in means was not due to chance; –, indicates the difference in means was due to chance.

TABLE 4
Receiver Operator Characteristic Discrimination Analysis[a]

Score	Threshold	Specificity (% Correct Category 1)	Sensitivity (% Correct Category 3)	Accuracy ([Sensitivity + Specificity]/2)
KJOC	<81.3	90.2	100.0	95.1
DASH	>3.33	87.8	90.0	88.9
DASH sports module	>37.5	100.0	70.0	85.0

[a]Report of threshold mean for accurately discriminating between categories 1 and 3 (subjects that are still competing and subjects that are no longer competing). The Kerlan-Jobe Orthopaedic Clinic Overhead Athlete Shoulder and Elbow (KJOC) score threshold demonstrated superior accuracy. DASH, Disabilities of the Arm, Shoulder and Hand.

elbow laxity.[10] Although gross medial instability can be detected on examination, it is difficult to report on quantifiable degrees of laxity. This difficulty is partly because of the rotation at the shoulder, which occurs when applying a valgus stress across the elbow. Furthermore, no evidence has proven stress radiographs to be reliable, objective measurement tools.[11,20,22]

As objective measures are of questionable use in this case, there is a need for a validated subjective outcome tool to report the results of UCL reconstruction. Such a tool would allow parametric scores to be reported, along with the current standard reporting of the athlete's ability to return to play. The KJOC score was designed as such a tool for specific use in the throwing athlete. It is an efficient, self-administered questionnaire that takes the athlete less than 2 minutes to complete. The questions focus on relevant issues such as endurance limitations, changes in mechanics, velocity or control issues, and patient perceptions of current level of performance.

This study reports the results of UCL reconstruction in 55 professional baseball players using the KJOC score compared with other validated outcome measures. We found a significant negative correlation between the KJOC score and both the DASH and DASH sports module, with lower scores in the latter 2 indicating higher function. The higher correlation between the KJOC score and the DASH sports module than the KJOC score and DASH further strengthens the validation of the KJOC score because both the KJOC score and the DASH sports module were designed with athletics in mind. These findings are consistent with the results of our previous validation study.[1] In addition, the previous KJOC score validation study reported a Cronbach α value of 0.9, indicating a high level of inter-item reliability.

The KJOC score is a validated outcome measure designed specifically for assessment of the high-demand overhead athlete. The 10-item questionnaire is easy to use for both patient and examiner, and clearly focuses on the demands of this type of athlete. Our study displayed good correlation with other validated outcome measures with respect to UCL reconstruction. In addition, the KJOC score was the only effective tool in discriminating between players playing with pain (category 2) and not playing because of pain (category 3), and it was also the only tool that discriminated between players playing without pain (category 1) and normal, uninjured players (category 0).

The KJOC score threshold of 81.3 was more sensitive and accurate than either of the threshold scores for the DASH (3.33) or DASH sports model (37.5) in differentiating between throwers playing without pain (category 1) and throwers not playing because of pain (category 3). A KJOC score above 81.3 indicates with 95.1% accuracy that a patient has returned to play, compared with only 88.9% and 85% accuracy for the threshold values of the DASH and DASH sports model, respectively.

Although this article describes an important tool for the follow-up of athletes undergoing UCL reconstruction, certain limitations should be discussed. First, an a priori power calculation was not conducted to determine the number of necessary patients to do such a study. However, there were statistically significant differences among the categories, a factor that demonstrates adequate power. Further validation would still be desirable, particularly for category 2 (playing with pain) in which the sample size was small, but we were limited by the number of professional baseball players that had undergone UCL reconstruction.

Another limitation may be the complete subjectivity of the KJOC score. A trend has developed over the last several years toward reporting the results of surgical procedures with subjective assessment questionnaires completed by patients.[26,28] The reasoning behind this trend is that success or failure of a procedure ultimately depends on the patient's perception of the result. Recently, this practice has been called into question.[32] Zarins[32] wrote an editorial published in the *Journal of Bone and Joint Surgery* in 2005 suggesting that objective measurements (eg, physical examination findings, radiologic studies) need to be correlated with patient symptoms for a more complete picture. Objective measurements allow surgeons to critically evaluate their performance and thus make refinements in technique that could potentially enhance patient outcome. We agree that objective assessments are important components to include in reporting surgical outcomes, provided they are both pertinent and reliable. Further research is necessary for various surgeries or conditions to determine the appropriate role for both subjective and objective assessment methods.

In conclusion, the results of this study support the use of the KJOC score as an outcomes assessment tool for UCL reconstructions in high-level overhead athletes. These results suggest that the KJOC score may have advantages in measurement of subtle performance changes in this high-demand patient population, and will be a useful adjunct to existing outcomes measures in evaluating results of this important surgery.

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REFERENCES

1. Alberta FG, ElAttrache NS, Bissell S, et al. The development and validation of a functional assessment tool for the upper extremity in the overhead athlete. *Am J Sports Med*. doi: 10.1177/0363546509355642.
2. Andrews JR, Timmerman LA. Outcome of elbow surgery in professional baseball players. *Am J Sports Med*. 1995;23(4):407-413.
3. Atroshi I, Gummesson C, Andersson B, Dahlgren E, Johansson A. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: reliability and validity of the Swedish version evaluated in 176 patients. *Acta Orthop Scand*. 2000;71(6):613-618.
4. Azar FM, Andrews JR, Wilk KE, Groh D. Operative treatment of ulnar collateral ligament injuries of the elbow in athletes. *Am J Sports Med*. 2008;28(1):16-23.
5. Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand outcome measure in different regions of the upper extremity. *J Hand Ther*. 2001;14(2):128-146.
6. Bernas GA, Thiele RA, Kinnaman KA, Hughes RE, Miller BS, Carpenter JE. Defining safe rehabilitation for ulnar collateral ligament reconstruction: a biomechanical study. *Am J Sports Med*. 2009; Epub ahead of print.
7. Ciccotti MG, Siegler S, Kuri JA 2nd, Thinnes JH, Murphy DJ 4th. Comparison of the biomechanical profile of the intact ulnar collateral ligament with the Jobe and the Docking reconstructed elbow: an in vitro study. *Am J Sports Med*. 2009;37(5):974-981.
8. Conway JE, Jobe FW, Glousman RE, Pink M. Medial instability of the elbow in throwing athletes: treatment by repair or reconstruction of the ulnar collateral ligament. *J Bone Joint Surg Am*. 1992;74(1):67-83.
9. Dines JS, ElAttrache NS, Conway JE, Smith W, Ahmad CS. Clinical outcomes of the DANE TJ technique to treat ulnar collateral ligament insufficiency of the elbow. *Am J Sports Med*. 2007;35:2039-2044.
10. Dodson CC, Thomas A, Dines JS, Nho SJ, Williams RJ, Altchek DW. Medial ulnar collateral ligament reconstruction of the elbow in throwing athletes. *Am J Sports Med*. 2006;34:1926-1932.
11. Ellenbecker TS, Mattalino AJ, Elam EA, Caplinger RA. Medial elbow joint laxity in professional baseball pitchers: a bilateral comparison using stress radiography. *Am J Sports Med*. 1998;26:420-424.
12. Fleisig GS, Andrews JR, Dillman CJ, Escamilla RF. Kinetics of baseball pitching with implications about injury mechanisms. *Am J Sports Med*. 1995;23(2):233-239.
13. Gibson BW, Webner D, Huffman GR, Sennett BJ. Ulnar collateral ligament reconstruction in Major League baseball pitchers. *Am J Sports Med*. 2007;35:575-581.
14. Hudak P, Amadio P, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). *Am J Ind Med*. 1996;29(6):602-608.
15. Hurbanek JG, Anderson K, Crabtree S, Karnes GJ. Biomechanical comparison of the docking technique with and without humeral bioabsorbable interference screw fixation. *Am J Sports Med*. 2009;37(3):526-533.
16. Indelicato PA, Jobe FW, Kerlan RK, Carter VS, Shields CL, Lombardo SJ. Correctable elbow lesions in professional baseball players: a review of 25 cases. *Am J Sports Med*. 1979;7(1):72-75.
17. Jobe FW, Stark H, Lombardo SJ. Reconstruction of the ulnar collateral ligament in athletes. *J Bone Joint Surg Am*. 1986;68(8):1158-1163.
18. Kleinbaum DG, Kupper LL, Nizam A, Muller KE, eds. *Applied Regression Analysis and Multivariate Methods*. 3rd ed. Pacific Grove, CA: Duxbury Press; 2008.
19. Large TM, Coley ER, Peindl RD, Fleischli JE. A biomechanical comparison of 2 ulnar collateral ligament reconstruction techniques. *Arthroscopy*. 2007;23(2):141-150.
20. Lee GA, Katz SD, Lazarus MD. Elbow valgus stress radiography in an uninjured population. *Am J Sports Med*. 1998;26:425-427.
21. McAdams TR, Lee AT, Centeno J, Giori NJ, Lindsey DP. Two ulnar collateral ligament reconstruction methods: the docking technique versus bioabsorbable interference screw fixation. A biomechanical evaluation with cyclic loading. *J Shoulder Elbow Surg*. 2007;16: 224-228.
22. Meyers A, Palmer B, Baratz ME. Ulnar collateral ligament reconstruction. *Hand Clin*. 2008;24:53-67.
23. Nissen CW. Effectiveness of interference screw fixation in ulnar collateral ligament reconstruction. *Orthopedics*. 2008;31(7):646.
24. Paletta GA Jr, Wright RW. The modified docking procedure for elbow ulnar collateral ligament reconstruction. *Am J Sports Med*. 2006;34: 1594-1598.
25. Petty DH, Andrews JR, Fleisig GS, Cain EL. Ulnar collateral ligament reconstruction in high school baseball players. *Am J Sports Med*. 2004;32(5):1158-1164.
26. Popowitz RL, Zvijac JE, Uribe JW, Hechtman KS, Schurhoff MR, Green JB. Rotator cuff repair in spinal cord injury patients. *J Shoulder Elbow Surg*. 2003;12(4):327-332.

27. Purcell DB, Matava MJ, Wright RW. Ulnar collateral ligament reconstruction: a systematic review. *Clin Orthop Relat Res*. 2007;455: 72-77.
28. Rubenthaler F, Wiese M, Senge A, Keller L, Wittenberg RH. Long-term follow-up of open and endoscopic Hohmann procedures for lateral epicondylitis. *Arthroscopy*. 2005;21(6):684-690.
29. Suk M, Norvell DC, Hanson B, Dettori JR, Helfet D. Evidence-based orthopaedic surgery: what is evidence without the outcomes? *J Am Acad Orthop Surg*. 2008;16(3):123-129.
30. Thompson WH, Jobe FW, Yocum LA, Pink MM. Ulnar collateral ligament reconstruction in athletes: muscle-splitting approach without transposition of the ulnar nerve. *J Shoulder Elbow Surg*. 2001;10(2): 152-157.
31. Vitale MA, Ahmad CS. The outcome of elbow ulnar collateral ligament reconstruction in overhead athletes. *Am J Sports Med*. 2009;36:1193-1205.
32. Zarins BE. Are validated questionnaires valid? *J Bone Joint Surg Am*. 2005;87:1671-1672.