The relationship among strength and mobility measures and self-report outcome scores in persons after rotator cuff repair surgery: Impairment measures are not enough

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In the past, measures of active range of motion and strength testing were deemed sufficient to "prove" the efficacy of treatment interventions. In the current outcomes milieu, however, the focus has shifted to patient-centered assessment (ie, patients' ability to perform activities that are personally relevant). We report results from a study with patients in the private practice of a shoulder surgeon. In this study we evaluated the relationship between impairment measures and scores from several shoulder outcome scales. In addition, we examined transcripts of interviews with shoulder patients regarding the impact of shoulder problems on their lives. One hundred eight persons participated in a randomized trial of home exercise instruction after arthroscopic repair of rotator cuff tears. Two impairment measures were used—strength estimates obtained by use of a Nicholas electronic dynamometer and range of motion in the standing position. Self-reported outcomes were measured by use of the Shoulder Pain and Disability Index (SPADI) and the University of Pennsylvania (UPenn) Shoulder Scale. Pearson correlation coefficients were calculated to estimate the associations between scores on impairment measures and self-report measures. R^2 *values were calculated to estimate the proportion of variance shared by impairment and self-report scores. We found that the linear relationship between impairment scores and patient-reported outcomes was quite low, explaining as little as 8% of the total variance. Qualitative analysis of patient interviews suggests that patients distinguish between their impairment and their status on personally relevant outcomes. Future research should evaluate the nature of patient judgments of shoulder health outcomes. (J Shoulder Elbow Surg 2005;14:95S-98S.)*

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Until recently, few investigators challenged the prevailing medical view of health. Medicine perceived health as an observable, biologic fact, and the goal of medical assessment was to objectively evaluate the body's status. Because patient reports of health status are subjective, they were considered unreliable and unscientific. The use of self-reports to evaluate health and health outcomes, however, has burgeoned in the last 10 to 20 years, as has the authority assigned to patients' evaluations. Sullivan[14] described this move toward a "new subjective medicine" as a change in medicine's focus from patients' bodies to patients' lives. In the current milieu, self-reported perceptions of health, function, and health-related quality of life (often called patient-centered outcomes) are prominent. These outcomes have authority not in spite of their subjectivity but because of their subjectivity. The interest of health policy agents and third-party insurers in health care value and cost-effectiveness may have been at the root of the shift toward patient-centered outcomes.[14]

These trends have substantially impacted research in orthopaedic medicine. Whereas measures such as active range of motion and strength testing once were deemed sufficient to prove the validity of treatment interventions, today's evaluations often include patient self-reports. If changes in patients' scores on objective measures of impairment fully account for

patients' perceptions of changes in outcome, however, self-report measures are redundant and could be abandoned. Research is needed in orthopaedic settings to evaluate the relationship between objective measures of impairment and patients' self-reported outcomes.

The purpose of this report is to describe and report results from a study conducted in patients seeking shoulder treatment in the private practice of an orthopaedic surgeon and coauthor of this report (G.G.). In this study we evaluated the relationship between impairment measures and scores from several self-reported shoulder outcome scales. In addition, we examined transcripts of interviews with shoulder patients regarding the impact of shoulder problems on their lives.

METHODS

Study sample

One hundred eight persons participated in a randomized trial of home exercise instruction after arthroscopic repair of rotator cuff tears. A detailed description of the primary study methods and findings has been reported elsewhere.[13] Seven participants for the interview section of the study were recruited from the private practice of an orthopaedic surgeon specializing in shoulder surgery (G.M.G.).

Instrumentation

Two impairment measures were used. We obtained strength estimates by use of a Nicholas electronic dynamometer (Nicholas MMT Model 0116, Lafayette, IN). Strength was recorded for shoulder external rotation and internal rotation at 0° of abduction and for scapular elevation in the empty-can position of the arm in the plane of the scapula. A standard goniometer was used to obtain active range-of-motion values in the standing position. Collected were forward elevation, shoulder external rotation at both 0° and 90° of abduction, and internal rotation based on spinal level reached by thumb up back. Strength and range-of-motion values were compared with those of the uninvolved side. Scores were recorded as percentage strength/active range of motion of involved versus uninvolved side. Percentage scores were assigned point values as reported by Leggin et al[7] in their developmental work on the University of Pennsylvania (UPenn) Shoulder Scale. For example, a person with 60° of external rotation at 0° of abduction on the involved side and 74° on the uninvolved side has a percentage score of 81%. A point value of 8 of 10 possible points was assigned. These point values were assigned for each of the 4 range-of-motion measures, with 40 total points possible. With the strength values, for example, a person with 5.8 kg recorded for external rotation at 0° of abduction on the involved side and 7.6 kg on the uninvolved side has a percentage score of 76%. This converts to 16 of a possible 20 points for that test. Again, each of the 3 strength measures was assigned points, for a score of 60 total points possible. Using these total points for strength (60 points possible) and range of motion (40 points possible), we were able to evaluate the relationship between both strength and range of motion with patient self-reported pain and function measures.

Self-reported shoulder outcomes were measured by use of the Shoulder Pain and Disability Index (SPADI)[11] and the UPenn Shoulder Scale.[7] The SPADI is a self-report visual analog scale of shoulder pain and disability. The pain subscale has 5 items, and the disability subscale has 8. The UPenn Shoulder Scale self-report sections are composed of subscales for pain (3 items, 30 total points possible), satisfaction (1 item, 10 points possible), and function (20 items, 60 total points possible). The total self-report score included all 3 components, for a total of 100 points possible.[7]

A physical therapist (T.S.R.) and a psychometrician (K.F.C.) conducted the focused interviews of 7 participants with shoulder disorders. They were asked about a range of tasks and functions including activities at work, sports and hobbies, and activities around the house. Participants were invited to identify tasks and functions that were important to them and describe the impact their shoulder problems had on personally relevant activities.

Data analysis

Pearson correlation coefficients were calculated between scores on impairment measures and scores on self-report measures. Probability values (*P* values) were obtained to evaluate the statistical significance of the obtained correlation coefficients. Because these *P* values test the null hypothesis that there is no relationship at all between measures, this test of statistical significance represents a very "low bar" for evaluating the association between 2 measures. A more informative statistic is obtained by squaring the correlation coefficient (R^2). This statistic, also called the coefficient of determination, estimates the proportion of the total variance in 2 measures explained by the linear association between the scores of the 2 measures. A coefficient of determination equal to 1 would indicate 2 perfectly reliable measures that are assessing exactly the same thing. The coefficient of nondetermination ($1 - R^2$) is a statistical estimate of the amount of unexplained variance. Unexplained variance has 2 components. One component is the variance in scores that is unique to 1 of the measures. The remainder of unexplained variance is measurement error. In this study R^2 values estimated the proportion of variance in self-reported outcome scores explained by variance in impairment scores.

The original purpose of collecting data from participants in the focused interviews was to inform the development of items for a new scale of shoulder function, the Flexilevel Scale of Shoulder Function (FLEX-SF).[2] Because we thought these data could help us understand the unexplained variance in the comparisons we made in our study, we revisited the transcripts. The second review searched specifically for patient's views on impairment, shoulder status, and satisfaction with outcomes. Because the interviews were designed to serve a different research goal (item generation), they are not appropriate as a basis for definitive statements regarding the relationship between objective measures of impairment and subjective measures of shoulder outcomes. Our intention in the secondary review was to develop preliminary hypotheses that could be pursued in a future study.

Table I Pearson correlation coefficients (*R* values) and percentage of shared variance (R^2 values) between impairment values and UPenn, shoulder scale and SPADI ($P \leq .01$)

	UPenn				SPADI		
	Total	**Pain**	**Satisfaction**	**Function**	**Total**	**Pain**	**Disability**
Strength	$R = 0.443$ $R^2 = 19.6\%$	$R = 0.285$ $R^2 = 8.1\%$	NS	$R = 0.478$ $R^2 = 22.8\%$	$R = -0.485$ $R^2 = 23.5\%$	$R = -0.431$ $R^2 = 18.6\%$	$R = -0.527$ $R^2 = 27.8\%$
ROM	$R = 0.500$ $R^2 = 25\%$	NS	NS	$R = 0.590$ $R^2 = 34.8\%$	$R = -0.481$ $R^2 = 23.1\%$	$R = -0.464$ $R^2 = 21.5\%$	$R = -0.486$ $R^2 = 23.6\%$

NS, Not significant at $\alpha \leq .01$;ROM, range of motion.

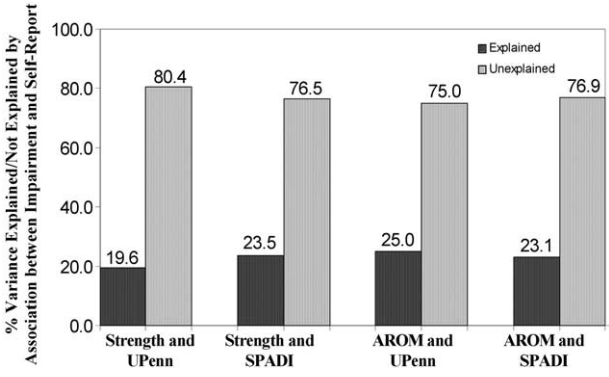

Figure 1 Percentage of shared variance (R^2) that was explained or not explained by the association between impairment measures (strength and active range of motion [*AROM*]) and self-report measures (UPenn and SPADI).

RESULTS

All significant ($P \leq .01$) correlation coefficients obtained between impairment and self-reported outcomes are listed in Table I. R^2 values also are listed. As reported in Table I, only 3 correlations were not statistically significant, demonstrating no linear relationship between scores of the UPenn satisfaction subscale and either impairment measure (strength or range of motion). There also was no statistically significant correlation between the UPenn pain subscale and range of motion.

We found the relationships between impairment and self-report measures to be quite low, explaining only a small portion of the variance in scores. This finding indicates that impairment measures and self-report measures were not equivalent in our study population. These values are represented in Figure 1.

With the focused interviews, we identified a number of comments that suggested patients' unique perspectives in evaluating shoulder outcomes. One interviewee, though not queried about the relationship between function and impairment measurement, commented explicitly on the topic as follows:

. . . During the impairment testing that tests your range of motion and [all] . . . I've gone through that, and that is so much bull, in my opinion, because I have full range of motion in my shoulder and my back. If they ask me to bend over and touch the ground, I can almost do it and I will almost [be] hollering and screaming in pain and will try and do it. So that gives me almost full range of motion. So that it [the testing] needs to be more involved than that.

Interviewee comments suggested that patients judged their shoulder status in relative rather than absolute terms. Asked to "pick a number from 0-10" that best described his satisfaction with his shoulder outcomes and explain how he arrived at his rating, one patient replied:

Well I started losing function in this shoulder before and this one wasn't an instantaneous kind of deal and I got to where I started carrying my wallet on my left side because I couldn't reach behind me to get my wallet out, I couldn't reach behind me.

This patient's response suggests a judgment made with reference not to his impairment alone but to his success or failure in minimizing the impact of the impairment on his life.

Patient interview data suggested that self-reported evaluations of shoulder outcomes are made by way of comparison to other factors. The following exchange occurred between one of the interviewers and a female patient:

Patient: "My shoulder does not cause me that much pain, misery, discomfort."

Interviewer: "Compared to . . . ?"

Patient: "Compared to my back. Even if I didn't have a very precious [sic] back, I don't think I'd complain about my shoulder. I've come a long way and I've never been a complainer."

In judging her satisfaction with her shoulder outcomes, this participant compares her status not only with her low-back dysfunction but also with her shoulder status in the past ("I've come a long way").

DISCUSSION

We found a large amount of the variance in our study population's self-reported function scores to be unexplained by impairment scores. This result is con-

sistent with findings in previous research. In a population of 30 persons with anterior cruciate ligament injuries, Neeb et al[9] found poor associations among responses to self-report knee outcome questionnaires and scores on clinical and functional tests. In a group of female college students, Heiderscheit et al[5] evaluated the effects of an 8-week isokinetic training and 8-week plyometric training program on softball throwing distance and power (as defined by isokinetic strength values). Although those who trained isokinetically significantly improved their scores on the isokinetic device, neither training group had an improved softball throwing distance. In a study population of patients after rotator cuff tendon repair, Gartsman et al[4] found that 80% to 87% of the variance observed in self-reported shoulder outcomes was unexplained by scores on impairment measures.

Our results and those of previous studies strongly suggest that impairment scales and shoulder outcome measures evaluate overlapping but qualitatively distinct entities. A competing hypothesis is that measurement error accounts for all of the unshared variance. This is highly unlikely, however, because previous work evaluating the reliability and validity of the measures used in this study indicates that they have relatively strong psychometric properties.[1,3,12]

Our findings suggest areas for further study. Patients appeared to make relative rather than absolute judgments when asked to rate their satisfaction with shoulder outcomes. This is consistent with research on subjective evaluations of health.[6] Future research should investigate the anatomy of patient judgments of shoulder health outcomes. One focus for this work is the impact of patient expectations on patients' evaluations of shoulder outcomes.[8,10]

Today, greater authority is being assigned to patients' subjective reports of clinical outcomes. This is evident in the move toward patient-relevant assessment in health outcomes research but is not limited to the research arena. Third-party payers increasingly require health care providers to demonstrate "success" by documenting improvement in patient-evaluated outcomes. In the current milieu, it is important to understand the relationship between objective measures and patient-evaluated outcomes. The nature of patients' subjective evaluations appears to be quite complex and warrants further study. Our findings and those of other investigators suggest that impairment scores fail to fully capture what patients rely on in evaluating their shoulder outcomes.

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