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ORIGINAL ARTICLE

The "tipping point" for 931 elective shoulder arthroplasties

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Background: A patient with arthritis usually experiences the progression of symptoms over time. At some stage, the patient may decide that the symptoms have reached a level of severity that leads him or her to elect to proceed with joint replacement; we refer to this degree of symptom severity as the "tipping point." Our goal was to study the factors that influenced the tipping point for patients undergoing elective shoulder arthroplasty.

Methods: We analyzed the characteristics of 931 patients undergoing shoulder arthroplasty to determine the factors affecting the tipping point as characterized by the patients' comfort and function at the time they determined their symptoms had progressed to the point when this elective surgery was merited.

Results: The preoperative Simple Shoulder Test (SST) score for all patients averaged 3.6 ± 2.7. The average tipping points were different for the ream-and-run procedure (mean SST score, 5.0 ± 2.5), hemiarthroplasty (mean SST score, 3.1 ± 3.3), total shoulder arthroplasty (mean SST score, 3.0 ± 2.4), cuff tear arthropathy arthroplasty (mean SST score, 2.8 ± 2.5), and reverse total shoulder arthroplasty (mean SST score, 1.5 ± 1.8). A number of other factors were significantly associated with a higher tipping point: younger age, better health, male sex, commercial insurance, married, nonuse of narcotics, use of alcohol, and shoulder problem not related to work.

Conclusions: Analysis of the tipping point—the patients' self-assessed comfort and function at the point they decide to undergo shoulder joint replacement—provides a means by which surgeons can understand the factors influencing the indications for these procedures.

Level of evidence: Level IV; Case Series; Prognosis Study

Keywords: Elective shoulder arthroplasty; tipping point; joint replacement; threshold for surgery; surgical indications; shared decision making

In its early stages, glenohumeral arthritis can be presumed to be asymptomatic. As the arthritis progresses over time, the symptoms are expected to progress as well. Elective shoulder arthroplasty is performed when a patient decides that his or her pain and loss of function have advanced to a magnitude sufficient to offset the time, costs, inconvenience, and risks of the procedure.[23] We refer to the patient's

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self-assessed shoulder comfort and function at the time he or she decides to undergo elective shoulder arthroplasty as the "tipping point," which is commonly defined as "the critical point in a continuous process beyond which a significant change takes place."[31] In our context, the "continuous process" is the progression of symptoms and the "significant change" is the decision to proceed with surgery.

While the term "tipping point" does not appear to have been previously used in the context of elective surgery, a number of publications have considered the point in the progression of a disease process at which an elective orthopedic procedure is performed.[2,6,10-12,16,19,42] In considering the timing of an elective operation, Barron[2] opined in 1969 that "The assessment of disability should not be measured in degrees of movement but in the ability or the inability of the patient to do what he wants to." Fortin et al[10] found no validated indications for when a patient should optimally undergo total joint replacement. Clark et al[6] found that accommodation to disability and pain and minimization of the perceived quality-of-life benefit for aging patients led to changes in the threshold at which patients elected to proceed with arthroplasty—a phenomenon that the authors referred to as a "moving target." Joshy et al[19] studied the ethnic differences in preoperative function of patients undergoing total knee arthroplasty, finding that the mean preoperative knee function score in Asian patients (32.5) was lower than that in white patients (45).

Several authors studied the preoperative Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) before total hip or knee arthroplasty (higher WOMAC values indicate worse impairment). In these studies, the WOMAC scores for patients with hip or knee arthritis were in the 40-42 range while the scores for those electing to undergo lower extremity arthroplasty were in the 50-65 range. The preoperative WOMAC score appeared to be affected by age, sex, comorbidities, and social support.[11,12,16,42] Various other studies have endeavored to determine the optimal timing of lower extremity joint replacement.[1,4,8,15,20,43,45]

We found no prior studies that sought to identify the tipping point for elective shoulder arthroplasty. Thus, the purpose of this investigation was to develop and apply a method for characterizing the tipping point for shoulder arthroplasty in a large group of patients electing to undergo this procedure at an individual shoulder arthroplasty center. We hypothesized that the tipping point for elective shoulder arthroplasty would be influenced by the patient's age, sex, and diagnosis and the procedure he or she elected to undergo.

Methods

We performed a level III prognostic study of 931 consecutive consenting patients enrolled in a longitudinally maintained shoulder arthroplasty institutional database and undergoing surgery from August 2010 to August 2017. For patients undergoing bilateral arthroplasty, we enrolled only the first shoulder treated in the study period. This practice is based in a tertiary referral center with approximately 78% of shoulder arthroplasty procedures performed in patients residing outside our metropolitan area. However, all patients are evaluated in the same manner in our clinic prior to making a decision regarding surgery by use of a careful history, physical examination, and standardized radiographs. Arthroplasty is presented as an option for patients with symptomatic osteoarthritis in whom conservative measures have been exhausted and who have a full understanding of the risks, benefits, and expected outcomes of the procedure.

At the time informed consent for surgery was obtained, we collected a wide range of data on the characteristics of the patient (eg, age; sex; marital status; body mass index [BMI]; tobacco, narcotic, and alcohol use; working status, prior surgical procedures; type of insurance; American Society of Anesthesiologists [ASA] class; diagnosis leading to arthroplasty; and Short Form 36 [SF-36]) and noted whether the patient lived in the same metropolitan area as our center (Appendix 1).[36,41] The patient also indicated his or her optimism for a positive outcome from surgery on a 0-10 scale, on which 10 was maximally optimistic. For each patient, the type of arthroplasty was determined by patient-surgeon decision making after a presentation using standardized patient information handouts.[27-30]

As a measure of the patient's self-assessed shoulder comfort and function prior to surgery, we collected responses to each of the 12 questions of the Simple Shoulder Test (SST), a validated tool commonly used to document the condition of the shoulder before and after shoulder arthroplasty.[18,24] The SST not only provides an overall score reflecting both the shoulder's comfort and function but also—in contrast to single-number assessments, such as the Subjective Shoulder Value, visual analog pain score, or Single Assessment Numeric Evaluation—captures the data on a standardized set of individual functions easily identified by patients considering shoulder arthroplasty.

Statistical analysis

Analyses were carried out for all patients and by individual surgery type. Descriptive statistics are presented as mean, standard deviation, and range for continuous variables and as number and percentage for categorical variables. Univariate association of risk factors with the preoperative SST was quantified by Spearman correlation (continuous risk factors) and by the comparison of medians (categorical risk factors) and was tested by the Spearman correlation and Kruskal-Wallis tests, respectively. Factors statistically significant in the univariate analysis were entered into a multivariate linear regression. To ensure validity of the confidence intervals and P values in the presence of non–normally distributed SST outcome, the multivariate analysis was limited to surgery types with at least 100 patients (actual sample sizes were 279-918 patients). The analysis was limited to patients with complete data (ie, all multivariate analysis risk factors present). Because the SST and SF-36 are both patient self-assessments of patient function and well-being, the multivariate analysis was carried out both including and excluding the SF-36. The analysis was carried out in R (version 3.3.1; R Foundation for Statistical Computing, Vienna, Austria). Because of the exploratory nature of the analysis, tests were not adjusted for multiple comparisons.

Results

The descriptive data for the patients included in this study are shown in Appendix 1. These patients were, on average,