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ORIGINAL ARTICLE

Establishing maximum medical improvement following reverse total shoulder arthroplasty for rotator cuff deficiency

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Background: Since US Food and Drug Administration approval of the reverse prosthesis in 2003, the incidence of shoulder arthroplasty in the United States has risen dramatically. With increasing demand, efforts have shifted from traditional volume-based health care models to more patient-centered care. The purpose of this systematic literature review is to establish the time point of maximum medical improvement (MMI) following reverse total shoulder arthroplasty (rTSA).

Materials and Methods: We conducted a systematic review of studies reporting validated patient-reported outcome measures (PROMs) across multiple postoperative time points following rTSA. Established minimal clinically important difference values for PROMs specific to shoulder arthroplasty were used to determine significant clinical improvement. The time point beyond which significant improvement did not occur was established as MMI.

Results: MMI occurred at 1 postoperative year following rTSA. When preoperative measures were compared with 1-year postoperative outcomes, all but 1 PROM demonstrated significant clinical improvement ($P < .001$). There were no significant improvements between any 2 subsequent time points beyond 1 year ($P > .050$). Range of motion significantly improved between preoperative and 1-year levels ($P < .001$). No PROMs or range-of-motion parameters significantly improved beyond 1 year ($P > .999$).

Conclusions: Patients achieved MMI at 1 postoperative year following rTSA. Patients showed rapid improvements in subjective symptoms within the first 3 months and continued to gradually improve until 1 year. Surgeons should counsel patients with these evidence-based expectations for clinical recovery, particularly the time frame of expected improvements in pain, function, and range of motion, as well as risks of and plans of action for postoperative complications.

Level of evidence: Level IV; Systematic Review

Keywords: Reverse total shoulder arthroplasty; shoulder arthroplasty; rotator cuff tear arthropathy; maximum medical improvement; rotator cuff; maximum improvement

The term "rotator cuff tear arthropathy" (CTA) refers to the degenerative glenohumeral arthritic changes and superior humeral head migration due to a chronic rotator cuff tear.[28] Multiple studies have demonstrated that reverse total shoulder

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arthroplasty (rTSA) leads to significant clinical improvements in postoperative function and pain in patients with CTA.[22,29,45] Since US Food and Drug Administration approval of the reverse prosthesis for shoulder arthroplasty for CTA in 2003, the incidence of shoulder arthroplasty in the United States has risen dramatically.[23] The number of shoulder arthroplasties increased 2.5-fold, from 19,000 in 1998 to 47,000 in 2008, and there were an estimated 66,000 procedures (rTSA in 33%) performed in 2011.[23,36] Furthermore, US demand for shoulder arthroplasty is projected to increase by over 750% by the year 2030.[30] Overall, total US health care spending reached nearly $3.4 trillion in 2016, and it is expected to represent 20.1% of the economy by 2025.[20] In the face of such demand and an aging population, efforts to optimize health care resource utilization have caused a shift from traditional volume-based health care models to more value-based, patient-centered care.[5]

In accordance with such initiatives, many health care providers are placing increased emphasis on patient-reported outcome measures (PROMs). PROMs are validated questionnaires that provide insight into the subjective patient experiences of symptoms, quality of life, and function, as well as their preferences, value systems, and goals.[24] These metrics have been used throughout orthopedic research to quantify and monitor patient improvement following surgery and are becoming increasingly incorporated into clinical decision making to foster a more patient-centered approach to care.[3,24] The minimal clinically important difference (MCID) establishes the minimum threshold of improvement in PROM scores that patients consider clinically beneficial.[17] Correlating PROM changes with previously established MCID values allows clinical researchers to effectively monitor subjective clinical patient improvement postoperatively. Furthermore, MCIDs can be used to determine the time point after surgery when patients stop experiencing significant clinical benefits, known as maximum medical improvement (MMI).[50] This concept is relevant because surgeons can counsel patients with evidence-based realistic expectations for clinical recovery after rTSA and patients can better understand how their clinical course should progress after surgery. Previous studies have established MMI for anatomic total shoulder arthroplasty, in addition to other shoulder procedures.[31,50] However, MMI has not yet been established for rTSA.

The purpose of this systematic literature review is to determine MMI following rTSA for rotator cuff pathology based on peer-reviewed evidence and validated PROMs. Our aim is that this study will serve to guide clinicians in appropriately orienting patients regarding their expected postoperative recovery, as well as to promote the creation of patient-centered health care policies.

Materials and methods

Systematic review and data collection

Two reviewers (B.C.C. and A.K.G.) independently searched the MEDLINE database on November 15, 2017. The following terms were used: "reverse total shoulder arthroplasty" or "reverse total shoulder replacement." The initial search produced 489 total unique articles. Two reviewers (B.C.C. and A.K.G.) independently screened the titles and abstracts to ensure that the procedure in question was rTSA and that clinical outcomes were reported. This left 207 full-text articles to be assessed. On full-text evaluation, studies were included if they reported PROM metrics following rTSA for at least 2 separate postoperative time points with a minimum of 2 years' follow-up. Only studies reporting rTSA for indications of CTA or some combination of rotator cuff deficiency with or without glenohumeral arthritis were included. Articles were excluded if they solely reported data for other surgical procedures (anatomic total shoulder arthroplasty, hemiarthroplasty, and so on); if outcomes were not reported at a minimum of 2 years' follow-up or were reported for only 1 postoperative time point; or if rTSA was performed for other surgical indications, such as proximal humeral fractures or humeral tumors.

If any uncertainty existed on screening, the full-length text was evaluated. If a study's methods may have qualified the article for inclusion but the reported data were insufficient, the authors were contacted via e-mail to obtain the data in question. Authors were given 30 days to respond to the inquiry. We also conducted a secondary search using citations of each included article to ensure all potential studies qualifying for inclusion were captured. The procedural steps for this search are illustrated in Figure 1.

The following data points were collected for each included article: authors, title, journal, publication date, date of postoperative follow-up relative to day of surgery, level of evidence, inclusion and exclusion criteria, number of patients initially enrolled, number of patients at each follow-up interval, number of study arms with description of each, mean age with range and standard deviation, number of each sex, implant system, complication rate, revision rate with reasons for revision, and PROM clinical outcomes. Clinical examination strength and active range of motion (forward flexion, abduction, and external rotation) were also collected from each article if reported. The PROMs reported in the included studies were as follows: American Shoulder and Elbow Surgeons (ASES) score; EQ-5D score; 36-Item Short Form Survey Mental Component Score and Physical Component Score; 12-Item Short Form Survey (SF-12) Mental Component Score and Physical Component Score; Short-Form Six-Dimension Health Index; Simple Shoulder Test (SST) score; University of California–Los Angeles Shoulder Rating Scale (UCLA) score; visual analog scale for pain (VAS); Absolute Constant-Murley Score (ACMS); Relative Constant-Murley Score; Constant-Murley Score (CMS) pain component; Disabilities of the Arm, Shoulder and Hand score; Shoulder Pain and Disability Index; and Subjective Shoulder Value.

After collection of PROMs, the MEDLINE database was searched to obtain published MCID values for each specific PROM, strength, and range-of-motion variable. The search was completed using the following terms: "MCID" or "minimal clinically important difference" in combination with "reverse total shoulder arthroplasty" or "reverse total shoulder replacement."

Statistical analysis

Data for each specific PROM metric were analyzed separately for all available postoperative time points for up to 5 years. The mean values for each PROM at each reported time point were pooled, and the pooled standard deviation was calculated. If only 1 article re-