

Cost-Effectiveness of Surgical and Nonoperative Management for Displaced Proximal Humerus Fractures in Patients Over 65: A 5-Year Markov Model Analysis

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INTRODUCTION:

Management of displaced three- and four-part proximal humerus fractures (PHFs) in elderly patients is controversial. From a surgical standpoint, reverse shoulder arthroplasty (RSA) has shown superior early functional outcomes compared to open reduction internal fixation (ORIF) in patients aged ≥ 65 years. However, the long term value of surgical versus nonoperative treatment remains uncertain. This study evaluates and compares the cost-effectiveness of nonoperative management, ORIF, and RSA in patients over the age of 65 that sustained a multi fragment proximal humerus fracture.

METHODS:

A 5-year Markov model was constructed for a cohort of patients aged ≥ 65 years with displaced 3- and 4- part PHFs, using data from a randomized controlled trial and national cost datasets. Health states included successful treatment, treatment failure (defined as nonunion or poor function requiring conversion), revision surgery, and death. Transition probabilities were derived from randomized controlled trials by Lopiz et al. (2025) and Fraser et al. (2024), including a 0% failure rate for nonoperative treatment and a 5% failure rate for RSA. Utility values were based on 12-month EQ-5D scores (RSA: 0.89; Non-Op: 0.83). Cost inputs were sourced from the HCUP-NIS and adjusted to 2025 USD using CPI rates reported by the U.S Bureau of labor and statistics (RSA: \$22,172.93; revision: \$25,060; ORIF: \$20,762.96; nonoperative care: \$2,918). A 3% discount rate was applied to both costs and utilities. Probabilistic sensitivity analysis (1,000 simulations) was used to reflect parameter uncertainty.

RESULTS: At 5 years, RSA yielded 3.83 quality-adjusted life years (QALYs) at a total cost of \$99,314.77 per patient, while nonoperative care resulted in 3.66 QALYs at \$12,872.09. The incremental cost-effectiveness ratio (ICER) was \$86,442.68/QALY, which was above the \$50,000 willingness to pay threshold. Although no patients that underwent nonoperative treatment required RSA, all patients in this group had fractures that healed in malposition. In the underlying trial ($n = 39$), there was no statistically significant difference between RSA and non-operative groups (mean difference 0.07; $p = 0.32$) or EQ-VAS score (mean difference = 5.1; $p = 0.10$). However, there were significant differences in the Constant score between patients that underwent RSA (62.5) and patients that underwent nonoperative treatment (50.7) ($p = 0.039$). The main difference in the Constant subscore values was the range of motion (ROM); the RSA group had a mean score of 27.3 vs 19.3 in the non-operative group ($p = 0.05$). Radiologic findings also indicated that osteonecrosis or osteoarthritis was present in all patients in the non-operative group.

At 5 years, RSA was found to be significantly more cost-effective than ORIF, while yielding higher utility as well. The total cost at the 5-year mark for ORIF was \$91,807.05, compared to \$99,314.77 for RSA. ORIF treatment provided 3.46 QALY at the 5-year mark. The ICER between RSA and ORIF was \$15,586.93/QALY, which was well below the \$50,000/QALY threshold. The target trial also indicated that RSA provided better functional outcomes after 5 years, with a mean Constant score of 71.7 compared to 58.3 for ORIF ($p < 0.002$). Further breakdown indicated that patients that underwent RSA scored significantly better in the subscores of sleep (mean difference = 0.3; $p = 0.02$) and movement (mean difference = 2.1; $p < 0.001$). Patients that underwent RSA also had a higher Oxford Shoulder Score (mean difference = 5; $p = 0.003$). The cost-effectiveness scatter-plot demonstrates the results of the simulation comparing RSA to ORIF, with the majority of points falling under the willingness-to-pay threshold.

DISCUSSION AND CONCLUSION:

In the setting of displaced 3- and 4- part proximal humerus fractures, reverse shoulder arthroplasty showed the greatest quality-adjusted survival and function when compared to ORIF and nonoperative management. However, this increase in QALY was not found to be cost-effective compared to non-operative treatment. This indicates that from a cost effectiveness standpoint, non-operative treatment should continue to be considered the preferred option in patients over 65 years old, offering both clinical benefit and economic value. However, when surgery is performed, RSA should remain the preferred surgical treatment, especially in patients that desire to maximize shoulder function.

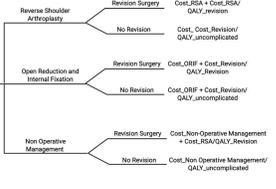


Figure 2: Incremental Cost-Effectiveness (ICE) Scatterplot from the Markov Model Comparing Reverse Shoulder Arthroplasty versus Non-Operative Treatment.

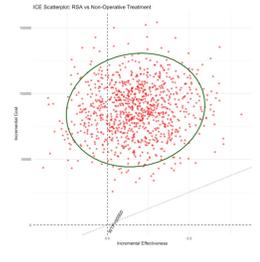


Figure 3: Incremental Cost-Effectiveness (ICE) Scatterplot from the Markov Model Comparing Reverse Shoulder Arthroplasty versus Open Reduction and Internal Fixation (ORIF).

