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ORIGINAL ARTICLE

Lateralization of the glenosphere in reverse shoulder arthroplasty decreases arm lengthening and demonstrates comparable risk of nerve injury compared with anatomic arthroplasty: a prospective cohort study

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Hypothesis: Grammont-style reverse shoulder arthroplasty (RSA) has an increased risk of nerve injury compared with anatomic total shoulder arthroplasty (TSA) due to arm lengthening. We hypothesized that an RSA with a lateralized glenosphere and 135° neck-shaft angle would reduce humeral lengthening and decrease the risk of nerve injury to the level of a TSA.

Methods: The study prospectively enrolled 50 consecutive patients undergoing RSA (n = 30) or TSA (n = 20) as determined by a power analysis based on previous research for our institution. Intraoperative neuromonitoring was used to detect nerve alerts during 4 distinct stages of the procedure. Preoperative and postoperative arm lengths were measured on scaled radiographs. Patients were examined immediately postoperatively and at follow-up visits for neurologic complications.

Results: Mean motor and sensory nerve alerts per case were similar for TSA and RSA (motor: TSA, 1.5 ± 2; RSA, 1.5 ± 2; $P = .96$; sensory: TSA, 0.6 ± 0.9; RSA, 0.2 ± 0.6; $P = .06$). The mean change in arm length was 3 ± 7 mm in the TSA cohort vs. 14 ± 7 mm in the RSA cohort ($P = .0001$). Temporary neurologic changes postoperatively were noted in 1 TSA and 1 RSA patient, amounting to a 4% incidence of nerve injury.

Conclusions: An RSA design with a lateralized glenosphere and a lower neck-shaft angle decreases arm lengthening compared with the Grammont design. The reduction in lengthening appears to eliminate the historically increased risk of neurologic injury associated with RSA relative to TSA.

Level of evidence: Level II; Prospective Cohort Design; Treatment Study

Keywords: Total shoulder arthroplasty; reverse total shoulder arthroplasty; neuromonitoring; neurologic injury; lateral offset; arm lengthening

The New England Baptist Hospital Institutional Review Board approved this study (Project Number 968636).

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Lengthening of the arm with reverse total shoulder arthroplasty (RSA) has been shown to be a risk factor for neurologic injury and accounts for a higher incidence of postoperative neurologic lesions compared with anatomic total shoulder arthroplasty (TSA).[1,4,5,8,11,12] In addition to clinical research, cadaveric and computerized biomechanical studies have demonstrated that the degree of lengthening from RSA is correlated with increased strain on the brachial plexus.[8,12] Although data on arm lengthening after RSA are limited, in 3 distinct samples, Lädermann et al[5-7] reported average arm length increases of 16 mm, 23 mm, and 27 mm using a validated measurement technique.

Existing research on arm lengthening and neurologic injury from RSA—including the 3 studies by Lädermann et al[5-7]—has exclusively involved Grammont-style reverse prostheses, which are defined for purposes of this study as having a medialized center of rotation (COR) and 155° neck-shaft angle (NSA). Designs with a lateralized COR and lower NSA may reduce arm lengthening, because they reduce the need for inferior translation of the humerus in favor of lateralization for adequate deltoid tensioning.

Neurologic complications from shoulder arthroplasty were largely overlooked because the incidence was originally reported to be low.[2,9] Recent studies have demonstrated substantially higher rates of neurologic lesions related to shoulder arthroplasty, with the greatest incidence associated with RSA.[1,5,11] Unfortunately, there continues to be poor consensus in the literature on how to evaluate neurologic injury in shoulder arthroplasty. Two studies of note rely on continuous intraoperative neuromonitoring (IONM),[10,11] in addition to a third study[3] that demonstrated feasibility and validity of the neuromonitoring technique in the open Latarjet shoulder procedure.

The present study used continuous IONM to compare the risk of nerve injury during anatomic TSA and RSA with a lateralized COR and quantify the degree of arm lengthening associated with each procedure. We hypothesized that lengthening in the RSA group would be less than that of historical reports on the Grammont design and that the number of intraoperative nerve alerts would be similar to that of the TSA control group, indicating comparable risk of neurologic injury.

Materials and methods

Patient enrollment

This was a prospective study of patients who elected to undergo primary TSA or RSA performed by the senior author (A.J.). Written informed consent was obtained from each patient. Patients were enrolled from March through August, 2017. Every eligible patient during the enrollment period was approached for consent to reduce bias and allow for consecutive cohorts. Depending on the type of surgery being performed, consenting patients were placed into the TSA control group or the RSA experimental group (Fig. 1).

In the TSA group, the indication for surgery was advanced glenohumeral osteoarthritis (OA) or avascular necrosis of the humeral head without significant rotator cuff or glenoid pathology. Indications in the RSA group included irreparable rotator cuff tear, rotator cuff arthropathy, and advanced glenohumeral OA with glenoid pathology that was determined by the senior surgeon to compromise the outcome of a TSA (ie, significant erosion or retroversion). The study excluded patients undergoing revision surgery or if indications for primary arthroplasty were fracture, humeral nonunion, or rheumatoid arthritis. Other exclusion criteria were neuropathy and significant medical comorbidities for which complete intravenous anesthesia without muscle relaxation (required for neuromonitoring) was considered an unacceptable medical risk by the surgical and anesthesia team.

Surgical technique

Exposure was achieved via a standard deltopectoral approach. The subscapularis was managed with a lesser tuberosity osteotomy for

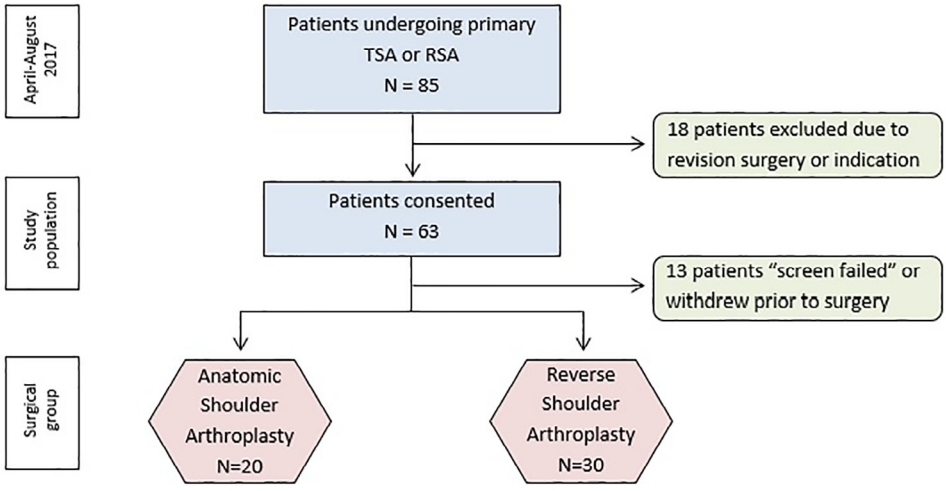

Figure 1 Study flowchart shows the enrollment process, study population, and breakdown of surgical groups. *TSA*, total shoulder arthroplasty; *RSA*, reverse shoulder arthroplasty.