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The risk of nerve injury during anatomical and reverse total shoulder arthroplasty: an intraoperative neuromonitoring study

Robert L. Parisien, MD[a], Paul H. Yi, MD[b], Laura Hou, MPH[c], Xinning Li, MD[a], Andrew Jawa, MD[c,*]

[a]*Department of Orthopaedic Surgery, Boston University Medical Center, Boston, MA, USA*
[b]*Department of Orthopaedics, University of California, San Francisco, San Francisco, CA, USA*
[c]*Department of Orthopaedics, New England Baptist Hospital, Boston, MA, USA*

Background: This study compared the incidence and pattern of potential nerve injuries between reverse shoulder (RSA) and total shoulder arthroplasty (TSA) using intraoperative neuromonitoring. Our hypothesis was that RSA has a greater risk of nerve injury than TSA due to arm lengthening.
Methods: We reviewed 36 consecutive patients who underwent RSA (n = 12) or TSA (n = 24) with intraoperative neuromonitoring. The number of nerve alerts was recorded for each stage of surgery. Neurologic function was assessed preoperatively and postoperatively at routine follow-up visits. Predictive factors for increased intraoperative nerve alerts and clinically detectable neurologic deficits were determined.
Results: There were nearly 5 times as many postreduction nerve alerts per patient in the RSA cohort compared with the TSA cohort (2.17 vs. 0.46). There were 17 unresolved nerve alerts postoperatively, with only 2 clinically detectable nerve injuries, which fully resolved by 6 months postoperatively. A preoperative decrease in active forward flexion and the diagnosis of rotator cuff arthropathy were independent predictors of intraoperative nerve alerts.
Conclusion: RSA has a higher incidence of intraoperative nerve alerts than TSA during the postreduction stage due to arm lengthening. Decreased preoperative active forward flexion and the diagnosis of rotator cuff arthropathy are predictors of more nerve alerts. The clinical utility of routine intraoperative nerve monitoring remains in question given the high level of nerve alerts and lack of persistent postoperative neurologic deficits.
Level of evidence: Level II; Prognosis Study

Keywords: Arthroplasty; Anatomic; Reverse; Nerve injury; Nerve monitoring; Motor evoked potential; Somatosensory evoked potential

Neurologic injury is a known complication of TSA, with reported incidences ranging from 1% to 4%.[1,12] These injuries are most often the result of brachial plexus stretch injuries that occur during positioning of the arm at the extremes of motion.[8,12] RSA may have a greater incidence of neurologic injury than TSA, possibly due to the resultant arm lengthening

The New England Baptist Hospital Institutional Review Board approved this study (approval protocol # 548025).

*Reprint requests: Andrew Jawa, MD, 840 Winter St, Waltham, MA 02451, USA.
E-mail address: andrewjawa@gmail.com (A. Jawa).

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and the need for increased glenoid exposure. However, data on the patterns and etiology of neurologic injuries during TSA or RSA are limited.[3,9,12-14,16-18]

Intraoperative nerve monitoring has been shown to be a useful tool used by orthopedic surgeons to avoid neurologic injury in spine surgery[6-8] and shoulder surgery, including TSA,[12,15,16] Latarjet for instability,[4] arthroscopy,[5] and fracture fixation.[20] Despite the previously reported utility of intraoperative nerve monitoring in orthopedics, and particularly during TSA,[12,16] no investigation has assessed the utility of intraoperative nerve monitoring during RSA or compared such monitoring between TSA and RSA.

The purpose of the present study was to compare the incidence and patterns of intraoperative nerve alerts between anatomic TSA and Grammont-design RSA, as detected by continuous intraoperative nerve monitoring, and to identify predictive factors for intraoperative nerve alerts during RSA and TSA.

Materials and methods

Patient selection

We retrospectively reviewed prospectively collected data of 36 consecutive patients who underwent RSA (n = 12) or TSA (n = 24) by a fellowship-trained surgeon (R.L.P.) at a single institution between March and September of 2013.

Inclusion and exclusion criteria

No patients were excluded. To be included in the study, all patients underwent an RSA or anatomic TSA procedure and provided a reliable postoperative clinical neurologic examination for the attending surgeon in the postanesthesia care unit immediately after surgery. All patients were included regardless of comorbid profile, history of rheumatoid arthritis, cervical spine disease, previous rotator cuff surgery, fracture sequelae, previous failed arthroplasty, and current or prior prescribed steroid use.

Surgical technique

Patients underwent RSA or TSA using a deltopectoral approach in the beach chair position with a pneumatic arm holder. The subscapularis was taken down with a lesser tuberosity osteotomy for the TSA and with a subscapularis peel (if present) for the RSA. The coracoacromial ligament was preserved in both procedures. A Zimmer (Warsaw, IN, USA) Anatomical prosthesis was used for all TSAs and a combination of a Zimmer Anatomical stem and a Zimmer Bigliani-Flatow baseplate and glenosphere were used in a Grammont-design RSA.

In both procedures, a humeral cut was made at the anatomic neck at the native version. In the RSA, according to the standard technique, there was some additional reaming of the metaphysis for placement of the onlay prosthesis, which has a 155° neck angle. The glenosphere baseplate was placed as low as possible on the glenoid without compromising fixation and with slight (approximately 5°-10°) inclination. The baseplate creates 2 mm of lateral offset.

Trial reduction was used to determine the optimal tension of the prosthesis. The aim was to obtain tension in which the prosthesis could just be manually reduced. The final trial was not actually reduced because of potential difficulty in redislocation. Therefore, the final prosthesis tension was determined by feel of the senior author (A.J.) with the goal of being "tight" to prevent instability. With nerve monitoring, the patient had no muscle relaxation. Stability was tested at the extreme of external rotation and adduction to assure stability after final reduction. The subscapularis peel or lesser tuberosity osteotomy were repaired with #2 nonabsorbable sutures passed through drill holes in the bicipital groove and wrapped around the prosthesis.

Peripheral nerve blocks were performed after the procedure in the postanesthesia care unit after a thorough neurologic examination by the attending surgeon. All patients underwent a further thorough neurologic examination on all postoperative days by the attending surgeon. No patients were discharged before the nerve block wore off.

Nerve monitoring

All patients underwent a standard anesthesia protocol with propofol for intubation and no muscle relaxation during the procedure. Continuous intraoperative nerve monitoring was recorded using transcranial electrical motor evoked potentials (MEPs), somatosensory evoked potentials (SSEPs), and free electromyogram (EMG), as previously described.[13] Stimulating leads were placed in the scalp, and recording leads were placed in the operative arm after sterile preparation and draping and in the nonoperative arm for reference. MEPs and free EMGs were recorded from deltoid, triceps, biceps, extensor carpi radialis longus, abductor pollicis brevis, and abductor digiti minimi muscles. SSEPs were recorded from the myotomes on the basis of major innervation patterns. Nerve alerts were defined as greater than 80% amplitude attenuation of MEPs or SSEPs, or both, compared with the contralateral arm. Each procedure was divided into 4 stages (surgical approach, humeral preparation, glenoid preparation, and postreduction), with the number of nerve alerts recorded per stage.

Study variables and protocols

At the initial preoperative evaluation, each patient was assessed for active range of motion as well as neurologic function, with no patient demonstrating any preoperative neurologic issues. In the immediate postoperative period, all patients were managed using the same standard shoulder arthroplasty protocol, which included a standard sling for 6 weeks with active assisted and passive range of motion, with external rotation limited to 20°. Each patient had a standard neurologic examination by the senior author (A.J.) in the recovery room each postoperative day and at each postoperative visit assessing the motor and sensory function of the axillary, musculocutaneous, radial, median, and ulnar nerves, respectively. Each patient was evaluated at 2 weeks postoperatively by the senior surgeon (A.J.), and if there was no clinically evident sensory or motor dysfunction (consistent with previous examinations), the patient was no longer monitored as part of this study protocol. If clinically evident neurologic dysfunction was seen, the patients were to be monitored until their symptoms completely resolved or there was no further improvement.