CASE REPORT

Procedure and role for intraoperative axillary nerve stimulation in reverse shoulder arthroplasty component sizing using a handheld biphasic motor nerve stimulator

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Background

The incidence of acute nerve injury, a feared complication, in TSA is quoted between 0.6 and 4.3%.[1-5] Furthermore, the recent recognition of late deltoid weakness, possibly related to chronic, unsuspected axillary nerve traction, mandates careful consideration.[6, 7] It has been hypothesized that lengthening of the arm, and therefore of the nerve, as well, in reverse shoulder arthroplasty may play a role in the incidence of neurologic injuries in this patient group.[8,9] Lengthening of the nerve is related to a reduction in its blood flow with levels of strain as low as 8%; complete arrest of blood flow may commence at 15% strain.[10, 11] Following reverse shoulder arthroplasty, segments of the brachial plexus may see as much as 19% lengthening.[12] Commensurate reductions in blood flow may explain the prevalence of neurologic symptoms in post-reverse shoulder arthroplasty patients. A simple means of assessing nerve health may be helpful in intraoperative decision-making and provide guidance to the surgeon during reverse shoulder arthroplasty in regards to consideration of pre-implant neurolysis and in optimal component sizing.

Intraoperative motor nerve assessment procedure

A biphasic handheld nerve stimulator (Checkpoint Surgical, Cleveland, Ohio) may be used in the intraoperative assessment of axillary nerve function through each step of a reverse shoulder arthroplasty procedure and provides a simple means of minimizing iatrogenic injury, improving function in already compromised nerves and preventing overstretching of the axillary nerve by assessing the nerve's relative response to baseline pre-strain stimulation parameters.

Stimulation of a normally functioning nerve with a stimulus intensity of 0.5 mA and 50-100 microseconds of pulse width duration produces a robust muscle response in the experience of our clinical practice. Excessive axillary nerve tension may be suspected in patients in whom threshold stimulus intensity increases following trial reduction. The "threshold stimulus" (the minimal stimulus intensity producing a visible deltoid contraction) is determined during the surgical approach. After placement of the trial components, the axillary nerve is tested again, noting whether the requisite "threshold stimulus intensity" is increased. Such an increase may reflect excessive tension on the nerve; consider downsizing the components, neurolysis of the nerve and other steps then check the threshold again. This comparative approach may be even more important in cases where fibrosis due to prior surgery provides constraining scar tissue that may reduce nerve mobility and potentially foster earlier strangulation of nerve blood flow.

In patients with a poor response to stimulation (lack of response at the lowest setting of 0.5 mA), nerve dysfunction may be suspected. Such patients may benefit from external neurolysis to remove the thickened epineurium frequently seen around the nerves in previously operated or injured shoulders.

Procedure for evaluating intraoperative nerve function in reverse shoulder arthroplasty

- Utilize the Checkpoint® stimulator during the surgical approach to positively identify the axillary nerve.
- Following initial surgical exposure of the axillary nerve, set the Checkpoint at 0.5 mA and 0 pulse width, place the stimulating tip in contact with the axillary nerve.
- Slowly increase the pulse width until initial muscle contraction of the deltoid is observed.
- Approximate and record required stimulation parameters to attain threshold muscle response. Patients with a poor response to stimulation (a threshold stimulus >0.5 mA is required) may benefit from neurolysis with removal of epineurial scar to improve nerve function.
- If exposure of the nerve is not routine in a surgeon's

reverse shoulder arthroplasty procedure, the device can be used in the same way but at higher amplitude-20 mA, thus activating the nerve by stimulating through the surrounding tissue.

- Proceed with dislocation of the joint and preparation for trial implant insertion.
- Proceed to placement of sizing component per standard clinical practice.
- Setting the Checkpoint at the previous amplitude and 0 pulse width, place the stimulating tip in contact with the axillary nerve or previous surrounding tissue is used in the first recorded stimulation.
- Slowly increase the pulse width until initial muscle contraction of the deltoid is observed.
- Approximate and record required stimulation parameters to attain threshold muscle response.
- If a higher pulse width than originally noted is required to achieve the level of deltoid contraction first elicited, consider downsizing the components, neurolysis of the nerve or other steps as appropriate.
- Assess acute change in responsivity of axillary nerve and assure that the nerve is able to return to its prior level of response before proceeding with the next smaller component.
- Continue as above until an acceptable device size has been chosen.
- Approximate and record required stimulation parameters to attain threshold muscle response.
- Implant permanent prosthesis.
- One additional stimulation test should be performed prior to closure to confirm nerve integrity at the completion of the procedure, and this should be documented.

Summary

Identifying subtle nerve dysfunction and deltoid weakness due to axillary neuropathy may improve deltoid strength in selected cases. Furthermore, minimizing implant-induced axillary nerve tension may enhance long-term outcomes. The Checkpoint biphasic nerve stimulator is a safe, essential tool not only to protect nerves from injury, but also to gauge how well they are functioning. Finally, this approach may also reduce liability for those surgeons who embrace and document this approach as a neuroprotective measure.

About the author

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