Specific evoked motor response for supraclavicular brachial block

Shahla Haleem, *MBBS, MD,* ***Maulana M. Ansari,*** *MBBS, MS,* ***Abdul Q. Khan,*** *MBBS, MS,* ***Abu Nadeem,*** *MBBS, MD,* ***Syeda M. Ahmad,*** *MBBS, MD,* ***Mehtab Alam,*** *MBBS, MD.*

ABSTRACT

Objective: To assess and evaluate the accuracy of individual types of evoked motor responses (EMRs) for prediction of successful surgical anesthesia following peripheral nerve stimulator (PNS) assisted supraclavicular block.

Methods: A prospective study was carried out over a period of one and half years from August 2004 to January 2006, at J. N. Medical College, Aligarh Muslim University, Aligarh, India, in 60 patients who underwent various elective operative procedures on the upper limb. Any of the EMR, such as forearm flexion or extension, carpal flexion, or extension, prono-supination, or finger flexion, at a definite current of 0.25 mA for 2 ms was taken as an end point for prediction of successful block, and a local anesthetic solution (0.375% Bupivacaine, 30 ml) was administered at that level.

Results: Complete surgical anesthesia was observed in those cases where EMR included: flexion of only second and third fingers (n=15/15) or flexion of all 4 fingers with thumb opposition (n=14/14) or uncommon flexion of all 4 fingers without movement of any other joint of the upper limb (n=2/2), suggesting a sensitivity of 100%. However, thumb opposition to the tip of the flexed little finger revealed a success rate of only 83% (n=5/6), and other EMRs were followed by high rates of inadequate surgical anesthesia or total failure.

Conclusion: Specific EMR of flexion of second and third fingers, or all the 4 fingers are reliable predictors of complete surgical anesthesia following PNS assisted single injection supraclavicular nerve block with no incidence of pneumothorax and nerve damage.

Neurosciences 2007; Vol. 12 (4): 299-301

From the Departments of Anesthesia (Haleem, Nadeem, Ahmad, Alam), Surgery (Ansari), and Orthopedic Surgery (Khan), J. N. Medical College, Aligarh Muslim University, Aligarh (U.P.), India.

Received 16th December 2006. Accepted 4th April 2007.

Address correspondence and reprint request to: Dr. Abdul Q. Khan, Lecturer and Consultant Orthopedic Surgeon, Department of Orthopedic Surgery, J. N. Medical College, Aligarh Muslim University, Aligarh (U. P.) 202002, India. E-mail: drabdulqayyum@rediffmail.com

Supraclavicular brachial plexus block is a well-established anesthetic technique, and definite evoked motor response (EMR) during nerve stimulation with peripheral nerve stimulator (PNS) is considered essential for subsequent successful block.[1] However, failures do occur requiring supplementation or conversion to general anesthesia. The incidence of failure in PNS assisted supraclavicular brachial plexus block varies from 1.2%[2] to 5%,[3] to 12%,[4] depending on the technique of nerve localization by EMR and injection of local anesthetic solution near the desired nerve. The EMRs such as forearm flexion or extension, carpal flexion, or extension, prono-supination, or fingers flexion have been taken as an adequate indicator of subsequent successful block.[5] However, none have documented the specific type of EMR for prediction of the complete sensory and motor block as an end point following supraclavicular approach, as has been carried out with respect to interscalene brachial block by Tonidandel and Mayfield,[1] and sciatic nerve block by Sukhani et al,[6] and Taboada et al.[7] Therefore, this prospective observational study was undertaken to assess and evaluate the accuracy of individual type of EMRs for prediction of successful surgical anesthesia following PNS assisted supraclavicular block.

Methods. Sixty healthy patients operated over a period of one and half years duration from August 2004 to January 2006, at J. N. Medical College, Aligarh Muslim University, Aligarh, India, scheduled for upper limb surgery were incorporated in the study after approval from the Institutional Board of Advance Studies. Exclusion criteria included patient's refusal, clinically significant coagulopathy, infection at injection site, and neurological deficit in the operative limb. However, patients with obesity, chronic pulmonary disease, and pregnancy were not excluded from the study. After informed consent, an intravenous line was secured in the pre-induction room, the patient was positioned supine; head rotated to the other side and a rolled towel was placed under the spine to make the supraclavicular area more prominent. Standard monitors including non-invasive blood pressure, electrocardiography, and pulse oximetry were applied. A light sedation consisted

of intravenous midazolam (0.04 mg/kg body weight) was given to all patients so they remained cooperative and awake throughout the procedure.

Anesthetic technique. After aseptic precautions, preparation of the skin and draping with sterile towels was carried out. Landmarks were palpated, and a point was chosen midway between the sternoclavicular and acromioclavicular joints, which are crossed by a line projected downwards from the external jugular vein. A Teflon-coated 22-gauge, 5 cm long insulated exploring needle (B. Braun) marked at 3 cm is inserted just lateral to the subclavian artery after anesthetizing the area with 2% lignocaine. A cathode is attached to the nerve stimulator at nerve locator mode, while an anode was attached to the patient via a cutaneous electrocardiogram electrode. The needle was inserted at an angle of 80^0 to the skin, directed backwards, inwards, and downwards in the direction of second and third thoracic spine,[8] to the upper border of first rib over which the plexus runs. The subclavian artery was pushed medially with the thumb of the other hand to avoid injury to the artery. The electrical stimulator TOF-Watch STM (SN: 09-2000038) was started and set to deliver a stimulus of 0.25 mA current for 2 ms at 1 Hz frequency. The intensity of the current was kept constant to minimize any change in needle tip position. The needle tip was advanced in an unhurried, gentle, and smooth manner to a maximum depth of 3 cms until an EMR was obtained, which was taken as an end point and no specific desired EMR was evoked by repeat insertion. A local anesthetic solution of 0.375% bupivacaine (0.5% bupivacaine 20ml mixed with normal saline 10 ml) was injected through the extension tubing attached to the needle, after confirming negative aspiration between each increment. Independent blinded observers recorded the specific EMR and evaluated the extent of sensory and motor blocks every 5 minutes until achieving readiness for surgery, or to a maximum of 20 minutes. The sensory block was assessed with pinprick and motor function was tested by asking the patient to abduct the arm at the shoulder joint against gravity, and flex the forearm at the elbow. In cases of inadequate anesthesia or failed block, no repeat supraclavicular injection was given but general anesthesia was administered to accomplish the surgery.

Results. In this prospective observational study, 60 patients underwent upper limb surgery under PNS guided supraclavicular brachial plexus block. All patients were demographically comparable, the mean age was 44.2±12 years, the mean height was 156±3.5 cms and weight was 50±5.7 kg. In the present study, 10 different types of EMRs were observed (**Table 1**). The most significantly observed motor responses were the flexion of middle and ring fingers in Group III (n=15; 25%) and flexion of all 4 fingers with thumb opposition in Group II (n=14; 23.3%), which were associated with comprehensive motor and sensory block providing complete surgical anesthesia with 100% success rate. The EMR of flexion of all 4 fingers without thumb opposition in Group IV was found less frequently (n=2; 3.3%) but was also associated with 100% successful block. The EMR of thumb opposition to flexed little finger in Group I (n=6; 10%) was associated with the success rate of only 83%. The EMRs of flexion/ extension at the elbow and wrist joints (Groups VI - IX)

Table 1 - Different types of evoked motor response observed during supraclavicular brachial block.

Evoked motor response		n	Onset of sensory blocks (mins)	Onset of motor blocks (mins)	Surgical anesthesia n (%)		
					Successful	Inadequate	Failure
Group I	Thumb opposition to the tip of flexed little finger	6	5.2±2.7	12±2	5 (83)	0	1 (17)
Group II	Flexion of all 4 fingers along with thumb opposition	14	5.0±2.0	7.5±1.6	14 (100)	0	0
Group III	Flexion of middle and ring finger	15	2.1±1.7	8.1±1.2	15 (100)	0	0
Group IV	Flexion of all 4 fingers	2	2.4±0.4	8±3.6	2 (100)	0	0
Group V	Flexion of index finger only	5	6.4±4.2	14±2.4	3 (60)	1 (20)	1 (20)
Group VI	Flexion of little and ring finger	4	4.6±4.4	10.4±1.2	3 (75)	1 (25)	0
Group VII	Flexion and medial rotation of hand	4	_	_	0	0	4 (100)
Group VIII	Carpal and elbow extension	4	_	_	0	0	4 (100)
Group IX	Flexion of forearm	2	_	_	0	0	2 (100)
Group X	Carpal flexion	4	_	_	0	0	4 (100)
Total		**60**	_	_	**42 (70)**	**2 (3.33)**	**16 (26.7)**

were associated with failed block. We did not observe complication of pneumothorax or nerve damage in any of our patients.

Discussion. The introduction of PNS in clinical anesthetic practice has created a sense of over reliance on it. However, recent studies indicate that the nerve stimulator assisted technique is not totally dependable, until, and unless it is combined with a clear and desired EMR.[9] Carlo et al[10] confirmed that it is the motor response that predicts the adequacy of block, not the intensity of current and this concept was adopted in the present study by using a definite current of 0.25 mA. The different observations in our study also confirm this. Depending upon the approach to the brachial plexus block, the observed response will exhibit distribution of the nerve. As in the infraclavicular approach, the plexus localization is at high axilla, the observed response will be distribution of end nerve, not the metameric characteristic as in the supraclavicular approach, where the stimulus will be at the trunk level, and the observed response usually attributed to the upper, middle, and lower trunk as all the 3 trunks are compactly arranged at this level. Consequently, the motor response may be prono-supination, flexion of forearm, carpal flexion extension, or flexion of fingers, and therefore, any of these responses should be reliable to predict the successful block, but this was not found true in clinical practice, as is also seen in the present study. These variations in success of the nerve plexus block have been thoroughly explained by the recent extensive study of Andres and Sala-Blanch.[5] They advocated, if flexor digitorum profundus muscle is contracted, which causes movement of third and fourth fingers, indicating stimulation of middle and lower trunk along with lateral/medial cord; the peripheral nerve involved will be the ulnar nerve. However, stimulation of the upper/middle trunk, as well as the medial cord will cause movement of first and second fingers, and the peripheral nerve involved will be the median nerve. As an end result, the flexor response of the second and third fingers, or all 4 fingers indicates both the ulnar and median nerve stimulation, and therefore, injection at this level will block both the ulnar as well as median nerve with prediction of complete surgical anesthesia.

In group II (flexion of all 4 fingers with thumb opposition) and group III (flexion of middle and ring fingers), the observed responses resulted from stimulation of both median and ulnar nerves with successful complete block. The simultaneous flexion of second and third fingers, and flexion of all 4 fingers with thumb opposition is the most frequently observed EMR, and hence is more reliable. However, thumb opposition to the tip of the flexed finger (Group I), again a reflection of stimulation of both median and ulnar nerves, is not always associated with successful block (success rate only 83%), possibly due to anatomical variations of different nerve fiber distributions at different levels, or due to stimulation of collateral nerves originating in the different zones of the brachial plexus as emphasized by Andres and Sala-Blanch.[5] However, the extensor response in group VIII may be stimulation of the radial nerve or flexion of forearm upon arm is due to stimulation of the musculocutaneous nerve, and as a result, these responses are not associated with successful block. Sensory block after elicitation of flexor response of elbow or wrist joint (groups IX and X) was also associated with failed block, requiring general anesthesia.

In conclusion, any positive motor response observed in PNS stimulation should not be considered to be the end point for local anesthetic injection for supraclavicular brachial block, because of a poor overall success rate of 70% as is evident from **Table 1**, but rather particular EMR of flexion of all 4 fingers with/without thumb opposition, or at least flexion of second and third fingers was the best predictor of unbeaten complete block. Furthermore, a gentle, smooth, unhurried technique coupled with single-attempt single-injection, safeguarding against needle insertion more than 3 cms and avoidance of repeat injection have resulted in complete freedom from pneumothorax and nerve damage, although their incidence were reported from 0.5-6%.[2]

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