Comparison of Interscalene brachial plexus blockade by eliciting multiple point paresthesia and electrical nerve stimulation techniques: a prospective, randomized trial

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Citation

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Abstract

Background: Despite worldwide use of regional blocks, interscalene block has failed to gain widespread acceptance in routine anesthesia practice owing to a higher risk of failure and untoward events. We intend to review its clinical applicability and compare the blockade features using two different techniques.Methods: We evaluated 110 patients of ASA physical status I-III at two centers over 2 years, receiving interscalene brachial plexus block and compared the blockade features of two techniques viz. eliciting paresthesia on multiple points and injecting local anesthetic (group MP, n=55) or injecting total dose of local anesthetic with needle immobilized on a single point after confirming muscular twitches using electrical stimulation at current amplitude of 0.3-0.6 mV (group ES, n=55).Results: Complete success, inadequate block and complete failure of block was observed in [92.7%; 5.45%; 0.9%] cases in MP group and [87.2%; 9%; 1.8%] cases in ES group respectively. The procedural time and time for readiness to surgery was 13±3.5min and 11.4±4.0min in MP group; 6.2±3.0 min and 15±5.6min in ES group p(<0.05). The number of needle pricks and passes was [2.1(1-3); 12 (9-21)] in MP group and [1.2(1-2); 7(5-12)] in ES group (p<0.01). Post-operative neurological dysfunction occurred in 4 cases MP/ES group: 3/1Conclusion: We conclude that either of the techniques is associated with minimal risk of complications and recommend their use in interscalene block depending on choice and experience of attending anesthesiologist.

INTRODUCTION

Peripheral nerve blocks are blind procedures performed on the basis on the knowledge of anatomical landmarks with varying results even in experienced hands.[1] Due to complexity and high incidence of complication and failure rates, there has been resistance to the routine use of interscalene regional block for shoulder or arm surgery. Currently, it is being performed at limited centers by few anesthesiologists, although availability of ultrasound guidance at few centers has improved the vision in placing this block.

The most common techniques of localization of the brachial plexus in interscalene (IS) approach are mechanical paresthesia (MP), electrical stimulation (ES) and recently introduced, ultrasound guided.[2,3] Paresthesia can be elicited using immobilized needle or multiple point injection technique.[4] Many studies have previously compared the efficacy and complications of different localizing techniques and several drug combinations in supraclavicular, infraclavicular or axillary approach to brachial plexus.[2-5] However, very limited research studies have compared nerve block performance using different techniques in interscalene block.[4] In a randomized, prospective fashion, we conducted this study to test the feasibility of localizing techniques by eliciting paresthesia (MP) on individual nerves (at multiple points) of interscalene brachial plexus and electrical stimulation of brachial plexus (ES) using immobilized needle technique and compare the blockade features in both the groups.

Our hypothesis was that success, failure and complication rates are not affected by the method of nerve localization in IS approach because needle insertion point is determined using same anatomical landmarks in both the groups. The primary outcome of this study was the success rate of IS block with both techniques in shoulder and arm surgeries. The secondary outcomes were the number of needle pricks and passes, time taken to perform the block, complication and failure rates by different methods of nerve localization.

MATERIAL AND METHODS

After obtaining ethical committee approval for the study and written informed consent, we studied 110 patients scheduled for shoulder or arm surgeries under interscalene regional anesthesia from 2008-2009 (2 years) at two centers, (Teerthanker Mahaveer Medical college and research institute, Moradabad and Subharti Institute of medical sciences, Meerut (40:70 cases respectively). Patients in age group 18-70 yr and ASA grade I to III were randomized into one of two groups of nerve localization using lottery method and then assigned to either group (ES/MP) by the co-investigators. Exclusion criteria included patients with contraindication to IS block i.e. skin infection at injection site, allergy to local anesthetic, severe pulmonary disease or neurological deficits in the operative arm or who refused regional anesthesia. Procedures included reduction of shoulder dislocation, interlock nailing or plating for fracture of surgical neck, upper and middle end of shaft of humerus. Due to complexity of the procedure, the presence of co-investigator was essential during intraoperative management, thus the study was blinded to patient only (single-blinded).

Patients were transferred to the operating room and standard monitors were placed. All patients were given intravenous midazolam in a dose of 2 mg to achieve anxiolysis prior to the procedure. After proper positioning (head tilted to opposite side) interscalene grove was identified by rolling the finger laterally from the cricoid cartilage, i.e. the level of C6 vertebrae, posterior to sternocleidomastoid muscle between the belly of the anterior and middle scalene muscle. At the determined needle site, skin wheal was raised using local anesthetic and needle was inserted 3-4 cm deep, perpendicular to skin in all plains in slightly caudad, medial and posterior direction aimed at localizing ventral rami of C5-C7 nerve roots.

In patients randomized to the MP group interscalene block was performed with a 1.5 inch, 22 gauge long-beveled needle and paresthesia (explained to the patient as sensory perception, tingling or current like) on shoulder, arm, elbow or hand, was accepted as evidence of correct needle placement. On eliciting paresthesia, 8-12 cc of local anesthetic mixture was injected and needle redirected through same prick to locate paresthesia in any other nerves of brachial plexus, followed by delivery of another doses. If patient experienced severe pain during injection, the needle was withdrawn slightly, and the injection was continued. In situations where another paresthesia (posterior shoulder, neck, or chest) was reported by the patient, the needle was withdrawn and redirected accordingly.

In patients randomized to the ES group block was performed with a 1.5 inch, 22-g short-beveled insulated needle (Stimuplex®, B. Braun) using nerve locator (B. Braun Medical, Germany) with pulse duration 0.1 ms, frequency 2 Hz and current intensity initially set at 2 mA with gradual decrease to 0.3-0.6 mA. Motor response like deltoid muscle stimulation (axillary nerve), arm flexion (musculocutaneous nerve) or arm extension (radial nerve) at a current between 0.3-0.6 mA, was accepted as correct needle placement and total drug injected on a single point thereafter.

After obtaining satisfactory nerve localization with either technique, patients were given a mixture of local anesthetics containing 8 ml of Xylocaine with adrenaline 1:200000 (Neon labs, India) and bupivacaine 0.5% (Neon labs, India) 12 ml with 5 ml of saline added to it (total volume 25 ml). The volume and concentration of local anesthetics was kept equal in both groups to avoid bias in results. In both groups the initial needle insertion was counted as one “needle pass and prick” and subsequent redirections of the needle were counted as additional passes while retractions followed by repeated skin puncture were counted as separate pricks. In both the groups, time taken to perform block was counted from needle insertion to drug injection and time to achieve surgical anaesthesia was counted from drug deposition till confirmation of effect by loss of pinprick sensation from shoulder to elbow and inability to abduct the arm or flex the forearm. In case of pain on the start of surgery due to nerve sparing, analgesia was supplemented with circumferential infiltration of 10-15ml of local anesthetic mixture in upper arm. Patients complaining of persistent pain after local anesthetic infiltration were induced with general anesthesia using endotracheal intubation and the block was considered as failed.

The number of needle pricks and passes, intraoperative complications (respiratory difficulty, vascular puncture or seizures), inadequacy or failure of block and nerves commonly spared by either of the technique was noted. The recovery of neurologic function in operated limb and occurrence of paresthesia or dysesthesia of involved nerve was also recorded the next postoperative day. Patients who reported transient neurological deficit were followed till 3 months by the operating surgeon for residual deficits; persistence of symptoms thereafter to be concluded as permanent neurological sequel.

The data was analyzed using statistical software SPSS, version 12.1. Categorical data was analyzed using x^2 test while continuous variables were analyzed using Student t-test. Results are presented as median (range), number (percentage) and mean ± standard deviation for continuous variables. A p-value<0.05 was considered as statistically significant and p <0.01 as highly significant.

RESULTS

Power of our study was determined using success rate in previous studies of 93%. Taking success rate as primary outcome with -error of 5% and -error of 10%, a sample size of 30 patients was required but we enrolled 55 patients in each group.

The age and weight of patients was comparable with a non-significant difference in both the groups (Table 1).

Figure 1

Table 1: Patient Characteristics in both groups

Patient data	MP group	ES group	Significance
Age (yrs)*	46 (21-64)	43 (24-67)	NS
Male/female*	41/14	37/18	NS
Weight*	58 (42-87)	53 (41-78)	NS
ASA grade I/II/III	29/20/6	36/14/5	-

*: Mean with range; NS: Non-significant

The median number and range of needle punctures 2.1 (1-3) or passes12 (7-21) required for were significantly high in MP group compared to ES group [1.2 (1-2) punctures; 7 (5-12) passes] owing to the complete reliability of this technique on clinical experience and knowledge of anatomical landmarks. Due to technical assistance of nerve locating device, time required for locating the nerves was significantly less (p< 0.01) in ES group 6.2±3.0 min compared to MP group 13±3.5 min (Table 2).

Figure 2

Table 2: Characteristics of Interscalene block placement in both groups with statistical significance

Block Characteristics	MP group	ES group	Significance
No. of needle pricks*	2.1 (1-3)	1.2 (1-2)	S
No. of needle pass*	12 (9-21)	7 (5-12)	HS
Time to perform procedure (min)†	13±3.5	6.2±3.0	HS
Time to achieve surgical anesthesia (min)†	11.4±4.0	15±5.6	S
Operative time (min)†	96±31	101±35	NS
Inadequate block (no. of patients)	3 (5.45%)	5 (9%)	NS
Nerve spared (Su/R/A)	1/2/0	2/2/1	-
Complete Success (%)	92.7	87.2	NS
Complete failure	1 (0.9%)	2 (1.8%)	NS
Undesired responses	8 (14.5%)	5 (9%)	S
Major Complications	-	-	-
Neurological dysfunction (R/A/M)	2/1/0	1/0/0	S

Data described as median with range (*), number with percentage or mean± standard deviation

(†); NS: Non-significant; S: Significant; HS: Highly Significant; Su: Suprascapular; R: Radial; A: Axillary; M: Median

Inadequate block was observed in 3 patients of MP group and 5 patients of EP group due to sparing of radial, suprascapular or axillary nerve (Table 2). Complete failure of block occurred in 1 patient of MP group and 2 patients of ES group when pain was inadequately controlled with supplementary, thus necessitating general anesthesia. Complete block not requiring general anaesthesia or additional supplementation with local anesthetics occurred in 92.7% (51) patients of MP group and 87.2% (48) patients of ES group, which is comparable and statistically non-significant (p>0.05).

Undesired responses such as paresthesia or twitches of neck, posterior shoulder (over trapezius muscle) or chest wall were observed in 14.5% (8) patients in MP group and 9% (5) patients of ES group, with an overall rate of 11.8% (13 cases), requiring redirection of needle to elicit desired responses.

DISCUSSION

Interscalene brachial plexus block was first described by Winnie in 1970 but the technique had a high incidence of major complications like inadvertent injection in intrathecal space or vertebral artery with seizures. The technique later, underwent many modifications and has proved its safety in current studies.[5,6]

Despite the time-tested record of safety of these blind techniques, an inherent rate of block failure exists. Anatomical landmarks are variable from patient to patient and do not always correlate with the location of the underlying nerves or plexus, a major reason for block failures despite vast experience of anesthesiologists. Eliciting multiple point paresthesia helps overcome this problem by locating more nerves which might have missed owing to anatomical variations. Previous studies reported that multiple point injection avoids complication of large volumes of drug deposition (approximately 35 to 40 ml)[7,8] at single site, decreases the chance of nerve sparing by allowing spread along more caudal roots along with a decrease in time and dose of local anesthetic required to achieve blockade of shoulder and arm compared single point injection technique.[4,7]

Electrical stimulation of brachial plexus is also an established technique, though rarely studies have compared it with multiple point injection technique in interscalene block.[9,10] We performed electrical stimulation using single point injection as even minimal volumes of injected drug abolishes the conduction of current to nerves and makes further localization of nerves extremely difficult despite redirections of the needle in interscalene block. Also, the movements of patient or needle during drug instillation can cause misplacement of target nerve leading to inadequate or failed block. For these reasons, insufficient block was observed in 5.4% and 9% patients with complete failure in 1.8% and 3.6% patients of MP and ES groups respectively.

On the contrary, axillary brachial plexus blockade with multiple injection technique using nerve stimulator has shown to improve success rate in previous studies due to anatomical distribution of nerves.[8,9,11-15]

The number of needle puncture and passes required for eliciting paresthesia at multiple points was definitely higher compared to eliciting twitches on electrical stimulation in our study, though the quality of blockade was more satisfactory in MP group. The time required to perform procedure was also significantly more in MP group than ES group (13±3.5 vs. 6.2±3.0) indicating that efforts and patience required to perform this blind procedure without any assisting device are more, compared to performing with nerve stimulator. We observed a comparatively high success rate (92.7%) with multiple point injection compared to immobilized needle technique (87.2%) with equal volumes of local anesthetics. The volumes of local anesthetic used by investigators in ultrasound guided blocks range between 20-25 ml and are comparable to our study.[4,8,16]

Postoperative neurologic symptoms have been reported in 7-19% of patients after upper extremity nerve blocks, though the symptoms are usually short-lived and mild in severity.[4,7] The etiology of these transient neurological symptoms is multifactorial and can occur due to direct needle trauma (common with use of hypodermic needles), increased intraneural pressure owing to rapid injection, surgical trauma, positioning or prolonged inflation of tourniquet.[7] We observed postoperative neurological symptoms in four patients (3.6 %) in our study which is lesser than observed by Gregori et al. In two patients (MP group) the feeling of paresthesia was described as current like tingling sensation in shoulder (axillary nerve) and forearm (radial nerve) while other two patients (1MP/ 1ES group), had persistent numbness in arm posteriorly (radial nerve distribution). Fortunately, the symptoms in all cases resolved within a month post-operatively.

The incidence of eliciting undesired response was significantly more in MP group compared to ES group 14.5% (8) vs. 9% (5) patients, indicating that needle exploration in wrong planes is more likely to cause injury to vital structures resulting in higher complication and failure rates. Their occurrence is largely avoidable by direct visualization of brachial plexus under ultrasonographic guidance as reported in studies Fanelli and Mahrofer et al.[4,17,19,20]

No major complication like Horner's syndrome, recurrent laryngeal nerve palsy, seizures or permanent neurological dysfunction was encountered in our study, comparable with other studies (Table 3).

Figure 3

Table 3: Comparison of undesired events of our study with other researches (et al)

Features	Our Study (%)		Van de P.[15] (%)	Casati[16] (%)		Fanelli[4] (%)	Gregory[7] (%)	
	MP	ES					MP	ES
Failure Rate	1.8	3.6	3	Nil	Nil	6	6	4
PONS	5.45	1.8	Nil	Nil	Nil	7	9.3	10.1
Unintentional paresthesia	14.5	9	-	-	-	15	-	-
Major Complications	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Few limitations of our study were that it was not observer-blinded which could have led to bias in our study. Inability of the investigators to assess diaphragmatic movements on fluoroscopy due to lack of experience was another shortcoming. Though previous studies report nearly 100% incidence of paresis of ipsilateral diaphragm post-interscalene block, more researches are required to quantify the magnitude of this effect. Finally, the incorporation of ultrasound guided blocks could have added to precision and new dimensions in our study.

Performing paresthesia technique at multiple points requires more patience, procedural time and pricks but avoids deposition of large drug volumes whereby improving the success rate of IS block, though a slightly higher possibility of transient neurological dysfunction exists, as in our study.

CONCLUSION

We conclude that interscalene block is safe to perform with either techniques of eliciting provides better quality of blockade though added efforts and experience are required for comparable performance. We recommend use of either techniques based on experience and choice of attending anesthesiologist.

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