

COMPARISON OF TWO APPROACHES TO BRACHIAL PLEXUS ANESTHESIA FOR PROXIMAL UPPER EXTREMITY SURGERY: INTERSCALENE AND INTERSTERNOCLEIDOMASTOID

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We conducted a prospective, randomized study to compare differences between groups of patients given a brachial plexus block using an interscalene (IS) or an intersternocleidomastoid (ISCM) approach. Specific variables analyzed included overall success rates, time to achieve sensory and motor anesthesia, time to place block, and incidence of side effects.

For the study, 81 patients were randomized to receive a brachial plexus blockade using the IS or ISCM approach followed by general anesthesia for their surgical procedure. Intraoperative analgesics were controlled for in both groups. No differences in demographics, block success rate,

pain scale scores, and analgesia duration were noted between groups. The ISCM group required less time to complete the block (7.08 ± 2.9 min) compared with the IS group (9.62 ± 5.31 min) ($P = .039$), achieved a significantly higher rate of complete motor and sensory block at 30 minutes ($P = .032$), and had fewer side effects ($P = .049$).

Based on our results, we found that using the ISCM approach to the brachial plexus resulted in a faster onset of anesthesia and a higher ratio of complete block at 30 minutes compared with the IS approach.

Key words: Analgesia, brachial plexus, interscalene, intersternocleidomastoid, regional implications.

Providing adequate analgesia is a major challenge in patients undergoing outpatient orthopedic shoulder and proximal upper extremity surgery. In the past, these patients received aggressive inpatient parental opioid management for the first 24 to 48 hours postoperatively, but current practice emphasizes outpatient rather than inpatient management, making this approach no longer a viable option.¹⁻³ To address this, alternative methods of pain control that have little impact on patient recovery and mentation following discharge from the hospital have been explored. Of these alternative methods, the one that has been found to be particularly useful in patients undergoing proximal upper extremity surgery is blockade of the brachial plexus using an interscalene (IS) approach because it can be used solely to facilitate anesthesia and analgesia or as an adjunct to provide prolonged postoperative analgesia.¹⁻⁴

However, the IS approach also has been reported to be problematic in placement, secondary to difficult landmarks, and has a fairly high incidence of side effects. The IS approach has been anecdotally described, except by Winnie,⁵ as difficult to master, as having a relatively slow onset of action, and as being associated with side effects that includes Horner syndrome, hemidiaphragm block, and recurrent laryngeal nerve block.⁶⁻¹² Recently, Pham-Dang et al⁶ described a technique using an intersternocleidomastoid (ISCM) approach to achieve brachial plexus blockade. They reported that this approach could be performed in less than 5 minutes, was successful in achieving blockade in 93% of the cases, and resulted in a lower incidence of transient laryngeal nerve blockade than reported in previous studies when the IS approach was used.⁶ In our review of the literature, we found no direct comparative study in patients receiving brachial plexus blockade using the IS vs the ISCM approach. There-

fore, the purpose of this study was to determine whether differences existed between the IS and ISCM approaches in terms of placement, onset, analgesic efficacy, and side effect profile between groups of patients given brachial plexus blockade and general anesthesia for proximal upper extremity surgical procedures.

Methods

We enrolled 81 ASA physical status I or II patients, age 18 to 65 years, scheduled for elective shoulder and upper extremity surgery (at or proximal to the elbow) in this institutional review board–approved study after written informed consent was obtained. Exclusion criteria included history of chronic pain, seizure disorders, upper extremity vascular pathology, opioid addiction, allergy to study medications, or documented sensory or motor deficit of the surgical extremity. Following informed consent, all subjects were randomized into 1 of 2 groups using a random numbers table. One group was assigned to have their plexus analgesia using the IS approach, and the other was assigned into the ISCM approach group. Before initiation of the block, all subjects were informed that they would be receiving their blocks in the preoperative holding area, that they also would be receiving general anesthesia for their surgical procedure, and that the blocks were being placed preoperatively to help supplement their general anesthesia and facilitate postoperative analgesia. Before block placement, all subjects had intravenous (IV) access established and standard monitors placed, including noninvasive blood pressure, electrocardiograph, and pulse oximetry. All subjects were given 0 to 0.05 mg/kg of midazolam and 0 to 100 µg of fentanyl IV during placement of block. The total doses of midazolam and fentanyl were noted and recorded.

The subjects randomized to the IS group were placed in the supine position with their arms at their sides and heads turned away from the side to be blocked. After a skin prep using povidone-iodine solution and local skin infiltration with 20 mg of 2% lidocaine, the brachial plexus was identified using landmarks described by Winnie⁵ and located with a 22-gauge, 50-mm Stimiplex (product No. STIM-A2250, B-Braun, Bethlehem, Pa) needle connected to a peripheral nerve stimulator (stimulation frequency, 1 Hz; duration of pulse, 0.1 ms). The intensity of the stimulating current initially was set at 1 mA and then gradually decreased to 0.5 mA or less after the proper motor response at the deltoid and/or hand was observed. A total of 35 mL of 1% mepivacaine plus 0.2% tetracaine with epinephrine 1:200,000 was injected in 5-mL increments to achieve brachial

plexus blockade. Blockade of the cervical plexus was achieved using 5 mL of the same local anesthetic solution after repositioning the needle posterior to and below the sternocleidomastoid muscle (SCM) and advancing in a cephalad direction while injecting.

Subjects randomized to the ISCM group were placed in the supine position with their arms at their sides and heads turned away from the side in which the block was to be placed. After skin prep using povidone-iodine solution, the brachial plexus was identified using the ISCM approach as described by Pham-Dang et al.⁶ This approach is described as identification of the SCM triangle by palpation and placement of a skin mark at the inner border of the SCM clavicular head, 2 fingerbreadths (3 cm) above the sternal notch. Another skin mark is placed at the midpoint of the clavicle. After placement of a skin wheal with 20 mg of 2% lidocaine over the SCM skin mark, the brachial plexus was located using a 22-gauge, 50-mm Stimiplex B-Braun block needle inserted at the inner border of the clavicular head of the sternocleidomastoid muscle and directed caudally, dorsally, and laterally toward the midpoint of the clavicle, passing behind the SCM clavicular head and forming a 40° to 50° angle with the plane of the subject's gurney. A peripheral nerve stimulator was used to localize the brachial plexus with initial settings of 1 Hz and 1 mA until a deltoid and/or hand motor response was elicited.⁶ Once a motor response was elicited, the current on the nerve stimulator was decreased to 0.5 mA or less, and the needle was redirected to evoke an acceptable response. Mepivacaine 1% plus 0.2% tetracaine with epinephrine 1:200,000, 35 mL, then was injected in 5-mL increments. The superficial cervical plexus was blocked by using the same technique described when placing the IS block.

The *time to perform the brachial plexus block* was defined as the time from initial needle insertion to final needle removal. Sensory and motor blockade of all upper extremity nerves were evaluated every 5 minutes for 30 minutes after injection. Sensory blockade was determined in the primary innervation zones (C6-T1 dermatomes) by using a Semmes-Weinstein Monofilament device. The Semmes-Weinstein Monofilament device is a tool that applies a fixed force of 279 grams to the skin by deflection of a 6.65-gauge monofilament thread. Motor blockade was assessed using the following scale: 0, no motor deficit; 1, inability to raise arm for 2 seconds; 2, inability to raise arm and flex elbow but able to move fingers; and 3, inability to raise arm, flex elbow, or move fingers.

Total duration of analgesia was defined as the time from completion of the block to the time the subject experienced the first breakthrough pain and requested

postoperative analgesia. A *failed block* was defined when no degree of sensory or motor block was present at the time of transport to the operative suite. A *complete block* was defined when no sensation was felt at the primary innervation sites and the subject was noted to be unable to raise the arm, flex the elbow, and move the fingers. Side effects or complications and treatment actions taken were noted. Following block placement, all subjects were transported to the operative suite, and standard monitors that included a noninvasive blood pressure device, electrocardiograph, pulse oximeter, and capnography were placed. General anesthesia was induced with IV lidocaine, 0.5 mg/kg; propofol, 2 mg/kg; rocuronium, 0.3 to 0.6 mg/kg, or succinylcholine, 1.0 to 1.5 mg/kg; and fentanyl, 0 to 250 µg. All subjects were intubated with an endotracheal tube following induction, and anesthesia was maintained with isoflurane, 0.5% to 1.5% plus 70% nitrous oxide/30% oxygen. All subjects received ondansetron, 4 mg, IV approximately 15 minutes before the end of surgery. All medications administered intraoperatively were recorded on a data collection sheet. On completion of the surgical procedure, subjects were extubated and transported to the postanesthesia care unit (PACU), followed by admission to the same-day surgery unit (SDSU) and discharge to home or inpatient ward.

Subjects were assessed for pain on arrival and discharge from the PACU and SDSU or inpatient ward using a 0 to 10 verbal numeric scale in which a reported score of "0" indicated "no pain" and a score of "10" indicated "the worst pain imaginable." In addition, verbal numeric scale scores were obtained immediately preceding and every 15 minutes following administration of an analgesic. Amount and type of analgesia given in the PACU and SDSU were recorded but not controlled. On discharge, subjects were asked to document the date and time of the first painful sensation in the blocked extremity and the name, dose, and time of administration of the first pain medication taken at home. This information was recorded by the subject on a home data collection tool. Subjects were instructed that they would be contacted by telephone approximately 24 hours following discharge by an investigator to ascertain their postoperative analgesic requirements. Postrecovery analgesics were prescribed by the orthopedic surgeon and were not controlled by type or dose. Overall analgesic requirements were calculated by converting all analgesics to morphine equivalents for direct comparative analysis between groups. At 24 hours following discharge, subjects were asked to rate overall satisfaction with the level of postoperative analgesia using the fol-

lowing 5-point scale: 1, complete dissatisfaction with pain control; 2, dissatisfaction with pain control; 3, somewhat dissatisfied with pain control; 4, satisfaction with level of pain control; and 5, complete satisfaction with level of pain control.

The incidence of side effects, which included hematoma, circumoral numbness, tinnitus, vertigo, Horner syndrome, recurrent laryngeal nerve block, symptomatic hemidiaphragmatic paralysis, pneumothorax, and seizure, were noted during data collection and the postoperative period. Horner syndrome was identified by presence of such clinical signs as ptosis, miosis, flushing of the skin, and complaint of nasal congestion. Blockade of the recurrent laryngeal nerve was identified by presence of hoarseness of the voice. Symptomatic hemidiaphragmatic paralysis was identified by complaint of a mild sensation of difficulty in taking a deep breath. A chest radiograph was performed on any patient who complained of more than mild difficulty in taking a deep breath or shortness of breath to rule out pneumothorax. Long-term or delayed complications, including infection at the block site, parasthesias, motor deficits, neuralgias, and other complaints, were assessed during a postoperative follow-up by the operative surgeon approximately 14 days following surgery.

Inferential and descriptive statistics were used for data analysis. Descriptive statistics were used for demographic variables. A χ^2 test and the Fisher exact test was used to analyze all incidental data. A Mann-Whitney *U* test was used to analyze motor block scores and satisfaction scores. A Student *t* test was used to analyze verbal numeric rating scale scores, time to onset of sensory and motor block, duration of sensory and motor blockades, and postoperative analgesic requirements between groups. A *P* value of less than .05 was considered significant. Before initiation of the study, a power analysis was performed in which we assumed that subjects in the ISCM group would have an approximate 90% rate of complete block (sensory and motor) at 30 minutes compared with a 75% ratio in the IS group. By using a α of .20 and an β of .05, it was determined that we would need approximately 40 subjects in each group to achieve significance.

Results

A total of 81 subjects were enrolled in the study; 2 subjects in each group were withdrawn, leaving a total of 77 subjects for final analysis (IS, 39; ISCM, 38). Of the subjects withdrawn, 3 were because of complete block failure (2 in the ISCM group and 1 in the IS group), and 1 (IS group) was due to a complication not attributed to the block. No significant difference

was noted between the groups in relation to age, weight, height, gender, number of attempts to place block, surgical times, time required in the PACU, or time to discharge from the hospital. Preoperative medication requirements also were similar between the groups for midazolam (IS, 2.2 mg; ISCM, 2.1 mg) and fentanyl (IS, 57.5 µg; ISCM, 48.7 µg).

A significant difference in overall incidence of side effects was noted in the IS group compared with the ISCM group ($P = .049$). Analysis of individual side effects noted a higher incidence of Horner syndrome (50% vs 16%; $P = .001$), recurrent laryngeal nerve block (21% vs 5%; $P = .049$), and symptomatic hemidiaphragmatic paralysis (15% vs 3%; $P = .050$) in the IS group compared to the ISCM group (Figure 1). No incidence of pneumothorax was noted.

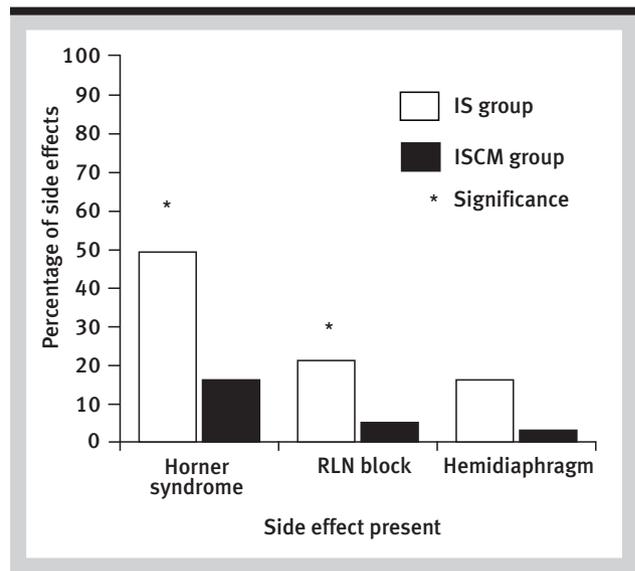
A significant difference was noted in the mean \pm SD time to perform the block between the IS group (9.62 ± 5.31 minutes) and the ISCM group (7.08 ± 2.9 minutes; $P = .039$) (Figure 2). Complete motor and sensory blockade was significantly greater at all time interval measurements in the ISCM group than in the IS group, with the exception of 20 minutes following block placement (Table 1). When individual dermatomal nerve distribution was analyzed, we noted that the most frequently missed nerve in both groups was the ulnar nerve. At 30 minutes following block placement, 92% ($n = 35$) of patients in the ISCM group had achieved blockade of the ulnar nerve compared with only 74% ($n = 29$) of subjects in the IS group ($P = .038$). No other differences were noted between groups for the radial, medial, and musculocutaneous nerves at 30 minutes ($P > .05$).

The verbal numeric scores for pain were not different between groups. The mean \pm SD time to first request for analgesia also was similar between groups (ISCM group, 416 ± 191 minutes vs IS group, 429 ± 181 minutes; $P = .767$). No statistically significant differences in overall analgesic satisfaction scores were noted between groups; most patients reported scores of 4 (satisfied) or 5 (completely satisfied) ($P = .226$). At the 2-week surgical follow-up, only 3 subjects had complaints. In each group, 1 subject reported soreness, and 1 subject in the ISCM group reported numbness and tingling at the injection sites. All complaints resolved spontaneously.

Discussion

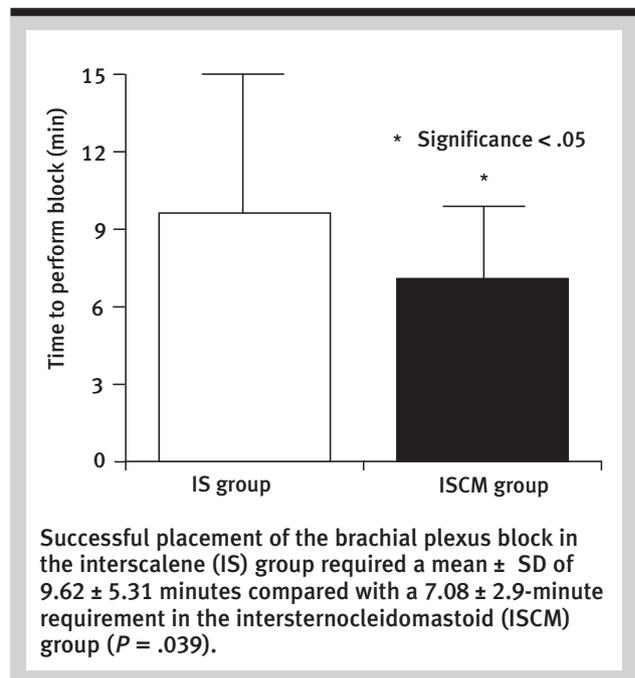
Brachial plexus anesthesia, when used in conjunction with general anesthesia, has been shown to reduce intraoperative anesthetic and postoperative analgesic requirements.² In our study, the IS and the ISCM approaches to brachial plexus anesthesia proved to be

Figure 1. Occurrence of side effects between the interscalene (IS) and intersternocleidomastoid (ISCM) groups represented as percentages



RLN indicates recurrent laryngeal nerve block; and hemidiaphragm, hemidiaphragm block.

Figure 2. Mean times to complete the peripheral nerve block



Successful placement of the brachial plexus block in the interscalene (IS) group required a mean \pm SD of 9.62 ± 5.31 minutes compared with a 7.08 ± 2.9 -minute requirement in the intersternocleidomastoid (ISCM) group ($P = .039$).

efficient methods of postoperative pain control for patients undergoing shoulder and proximal upper extremity surgery. The IS and ISCM approaches to brachial plexus block have similar cited disadvantages, including hemidiaphragmatic paralysis, Horner

Table 1. Comparison of subjects with a complete motor and sensory block of the radial, medial, ulnar, and musculocutaneous nerves at 5, 10, 15, 20, 25, and 30 minutes following block placement*

Time interval (min)	Group		P value
	IS (n = 39) N (%)	ISCM (n = 38) N (%)	
5	1 (3)	8 (21)	.012
10	7 (18)	15 (39)	.037
15	14 (36)	26 (68)	.004
20	24 (61)	31 (82)	.052
25	26 (67)	33 (87)	.036
30	27 (74)	35 (92)	.038

* Data are given as number (percentage). IS indicates interscalene; and ISCM, intersternocleidomastoid.

syndrome, and recurrent laryngeal nerve block.^{5,6,9-11} Subjects given a brachial plexus block using the ISCM approach experienced a significantly lower incidence of overall side effects. Due to the limited number of subjects enrolled, a repeated study with a larger sample is recommended to validate these results.

A common misconception regarding the performance of brachial plexus blocks is that it requires a lengthy period to perform and may slow room turnover. This study demonstrated that although the IS and ISCM approaches can be performed rapidly, ISCM brachial plexus block took less time to administer than IS brachial plexus block. Anesthesia staff and trainees anecdotally noted that the brachial plexus seemed easier to locate with the ISCM technique, which may explain the shorter time requirement for administration of the ISCM block. This may provide the advantage of decreasing any potential operating room delay related to performance of the block.

As stated earlier, the IS and ISCM are best suited for surgical procedures of the shoulder and upper arm at or above the elbow. Data verified greater blockade of median, radial, axillary, and musculocutaneous nerves, with both blocks exhibiting a greater degree of ulnar sparing. This is a common finding when these approaches to the brachial plexus are used. Therefore, if ulnar blockade is an absolute requirement, a separate blockade of the ulnar nerve may need to be performed at a position distal to the supraclavicular approach. In fact, it has been recommended that an axillary approach to the brachial plexus be used for surgical procedures of the hand and forearm to ensure that ulnar blockade is achieved.⁴ However, it was noted that 92% of the subjects in the ISCM group achieved ulnar blockade by 30 minutes following block place-

ment compared with 74% of the subjects in the IS group, which is consistent with results reported by Pham-Dang et al,⁶ helping to validate their findings. However, further studies need to be performed in which direct comparisons of these 2 techniques are performed to validate our findings of an 18% difference in success between the groups. It may be found that in more experienced practitioner hands, the success rates would be similar. Further studies will need to be performed comparing these 2 techniques to validate this finding. It should be noted that both groups reported similar postoperative analgesia pain scores and had similar postoperative analgesic requirements, indicating that this degree of nerve sparing between groups had no impact on postoperative analgesia, indicating that the IS approach achieved brachial plexus analgesia in the postoperative period.

This study was not designed to determine whether a difference in surgical anesthesia occurred between the groups because the brachial plexus blocks were used in conjunction with general anesthesia in all cases. Despite this limitation, we believe that this comparative study produced some important findings in terms of application and side effects. To determine whether one technique is superior to the other, this study needs to be repeated in a surgical population in which the 2 techniques are used as the surgical anesthetic. A plan to repeat this study to determine surgical efficacy between the groups is being formulated.

This study indicated that using the ISCM approach to achieve brachial plexus blockade may offer several advantages over the IS approach. Such advantages may be beneficial, especially with the continuously increasing trend toward outpatient surgical procedures.

REFERENCES

1. Dorman BH, Conroy JM, Duc TA, et al. Postoperative analgesia after major shoulder surgery with interscalene brachial plexus blockade: etidocaine versus bupivacaine. *South Med J*. 1994;87:502-505.
2. Brandl F, Taeger K. Combination of general anesthesia and interscalene block for shoulder surgery [in German]. *Anaesthesist*. 1991;537-542.
3. Gohl M, Moeller R, Olson R, Vacchiano C. The addition of interscalene block to general anesthesia for patients undergoing open shoulder procedures. *AANA J*. 2001;67:105-109.
4. Lanz E, Theiss D, Jankovic D. The extent of blockade following various techniques of brachial plexus block. *Anesth Analg*. 1983; 62:55-58.
5. Winnie A. Interscalene brachial plexus block. *Anesth Analg*. 1970; 49:455-466.
6. Pham-Dang C, Gunst JP, Gouin F, et al. A novel supraclavicular approach to brachial plexus block. *Anesth Analg*. 1997;85:111-116.
7. Sharrock N, Bruce G. An improved technique for locating the interscalene groove. *Anesthesiology*. 1976;44:431-433.
8. Ward M. The interscalene approach to the brachial plexus. *Anaesthesia*. 1974;29:147-157.

9. Urmey WF, Talts KH, Sharrock NE. One hundred percent incidence of hemidiaphragmatic paresis associated with interscalene brachial plexus anesthesia as diagnosed by ultrasonography. *Anesth Analg*. 1991;72:498-503.
10. Gerancher J. Upper extremity nerve blocks. *Anesthesiol Clin North Am*. 2000;18:297-317.
11. Hickey R, Ramamurthy S. The diagnosis of phrenic nerve block on chest x-ray by a double-exposure technique. *Anesthesiology*. 1989; 70:704-707.
12. Brown DL, Bridenbaugh LD. The upper extremity somatic block. In: Cousins MJ, Bridenbaugh PO, eds. *Neural Blockade in Clinical Anesthesia and Management of Pain*. 3rd ed. Philadelphia, Pa: Lippincott-Raven Publishers; 1998:351.

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