Low-Modified Interscalene Versus Traditional Interscalene Nerve Block Effects on Lung Function in a Morbidly Obese Population

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Introduction

Brachial plexus blockade can provide excellent analgesia for ambulatory shoulder surgery [1-3]. Patients that undergo perineural anesthesia have higher rates of patient satisfaction, shorter PACU recovery times, decreased opioid consumption, and less nausea and vomiting than cohorts receiving parenteral opioids [1-3]. Interscalene brachial plexus blockade has been used routinely for ambulatory shoulder surgery for decades [3]. The traditional interscalene brachial plexus block (TIBPB) has a 100 percent incidence of diaphragmatic paralysis, resulting in a 25-30% reduction in forced vital capacity (FVC). Obesity can result in a restrictive pulmonary syndrome and obstructive sleep apnea, both of which can be worsened by general anesthesia. Obese patients may be more prone to postoperative pulmonary complications. A modified, or low, interscalene block is defined as a brachial plexus nerve block below C6 but above the supraclavicular fossa. The purpose of our study was to determine if a modified interscalene block would prevent diaphragmatic paralysis while providing adequate pain control for morbidly obese patients undergoing shoulder surgery.

Methods:

15 patients with a BMI>35 who were scheduled to undergo shoulder surgery were selected. Patients were randomized to receive either a low-modified or a traditional interscalene nerve block. Both groups received 15ml of 0.5% ropivicaine for their brachial plexus block. Post-block lung function was assessed using incentive spirometry. Pain scores and need for supplemental oxygen postoperatively were also assessed.

Results:

The average decrease in lung volume in the group receiving the low-modified interscalene block was 1150ml, while the decrease in the traditional group was 860ml. The decrease in lung volumes between the two groups was determined to be non-significant (p=0.535).

Conclusion:

Low interscalene brachial plexus blockade is often described as a technique used to prevent phrenic nerve blockade and hemidiaphragmatic paralysis. Our group found that phrenic nerve blockade routinely occurred when using this technique in morbidly obese patients, as evidenced by equivocal reductions in incentive spirometry in both groups. Postoperative pain scores, respiratory complications, need for supplemental oxygen, and delay in discharge did not occur in either group. We found that low-modified interscalene brachial plexus blockade in morbidly obese patients provides no benefit.

Keywords: Interscalene Nerve Block, Diaphragmatic Paralysis, Morbid Obesity

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Abstract

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While unilateral phrenic nerve blockade is tolerated well by many patients, obese surgical patients are more likely to have adverse events as a result of unilateral phrenic nerve blockade than normal weight patients. Obese patients undergoing arthroscopic shoulder surgery have been shown to have increased operative times, worse functional outcomes, and increased length of hospitalization when compared to cohorts with a normal body mass index (BMI) [7]. These results may be attributed, in part, to the high incidence of restrictive pulmonary syndrome and obstructive sleep apnea in the obese population, as both comorbid conditions can be exacerbated by general anesthesia and administration of opioids [7,8]. Given such, obese patients undergoing TIBPB, with and
without pre-existing pulmonary conditions, may be more prone to intra and postoperative pulmonary complications.

Two strategies are commonly suggested to preserve diaphragmatic function in vulnerable patients, such as obese patients, receiving interscalene brachial plexus blockade – (1) use of a decreased volume of local anesthetic, and (2) targeting the brachial plexus at a lower level in the neck (2). Using a decreased volume of local anesthetic for interscalene blockade has been well studied, and it reliably decreases the incidence of hemidiaphragmatic paralysis when performed under direct visualization using ultrasound guidance [1,9-12]. Unfortunately, decreased volume blocks provide similar pain control initially; however, the low-volume block duration of action is much shorter [11,13].

A traditional interscalene brachial plexus block (TIBPB) is performed at the level of cervical vertebrae C6 [14]. A low interscalene brachial plexus block (LIBPB) is defined as being performed below the level of the C6 vertebrae, but above the supraclavicular fossa [3]. Below the level of C6, the phrenic nerve is located increasingly further away from the brachial plexus. In the general population, the incidence of hemidiaphragmatic paralysis during brachial plexus blockade performed at the level of the supraclavicular fossa is 25% [13-16]. Although the incidence of hemidiaphragmatic paralysis appears to be lower in the patient population undergoing LIBPB, no studies have examined the effectiveness of this technique in an obese surgical population. The purpose of this study was to determine if LIBPB preserves respiratory function in morbidly obese patients, determined by performance of inspiratory spirometry, while providing comparable pain control to TIBPB.

Methods

Patient Population

This study received approval from the institutional review board at West Virginia University.

Obese surgical patients undergoing arthroscopic shoulder surgery at J.W. Ruby Memorial Hospital (Morgantown, WV) in 2017. To be eligible for enrollment, patients had to be at least 18 years of age, have a BMI ≥ 35, and have no history of contraindications to anesthesia. Further, patients were excluded on the basis of the exclusion criteria summarized in Table 1. Informed consent was obtained from all eligible patients prior to the start of the study.

Study Design

Prior to surgery, subjects were randomly allocated to either the traditional TIBPB or the LIBPB group.

All nerve blocks were performed in the preoperative area. Intravenous access was established and standard ASA monitors were applied. Conscious sedation was administered using midazolam and fentanyl. Sedation was titrated to effect with a maximum dose of 2mg of midazolam and 100mcg of fentanyl per patient. Oxygen was administered via nasal cannula, and the skin was prepped with chlorhexidine. A high-frequency transducer attached to a Sonosite ultrasonic system was used for each block. The block was performed using a 2-inch 22-gauge stimulating needle and an inplane technique. Nerve stimulation was also used with an initial setting of 1.0 mA, 1 msec. A loss of nerve stimulation below 0.5 mA was used to avoid intraneural injection .

Patients in the TIBPB received an injection at the level of the C6 vertebrae. Patients in the LIBPB received an injection below the level of the C6 vertebrae at the trunk level of the brachial plexus. At this level, the subclavian artery was visualized on ultrasound, and the block was performed above the level of the supraclavicular fossa. 15 mL of 0.5% Ropivacaine was used for both treatment groups. Subsequently, all patients received general anesthesia for their shoulder surgery. The decision to use a laryngeal mask airway or endotracheal tube was determined by the intraoperative care team.

Measurement of Respiratory Function

Prior to sedation and performance of peripheral nerve blockade, the patient was given an incentive spirometer and instructed on its use. After each patient was appropriately acquainted with the incentive spirometer, they were asked to perform sustained maximal inspiration (SMI) three times. The average SMI was recorded. SMI was measured at three time points during the course of the study – baseline (prior to nerve block), 30 min post-nerve block, and 60 min post-operation.

Post-Operative Assessment

Patients were admitted to the post-anesthesia care unit (PACU) following the operation. The following measurements were recorded by perioperative nursing staff at 15 minute intervals for the first hour in the PACU – heart rate, blood pressure, oxygen saturation, and pain score using a numeric scale from 1-10. In addition, the administration of any pain medication or supplemental oxygen therapy at any time during PACU stay, and the total time spent in the PACU was recorded.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics® (Version 24). All study variables were assessed for normality using a Shapiro-Wilk test. Normally distributed continuous variables were expressed as means and compared using either an independent samples T-test, one-way ANOVA or repeated-measures ANOVA. Nonparametric continuous variables were expressed as medians and compared using a Mann Whitney U-test or Kruskal-Wallis ANOVA. Categorical variables were expressed as percentages and compared using a chi-square analysis. For all tests, a p-value ≤ 0.05 were considered statistically significant.

Results

A total of 15 patients were enrolled in this study. 8 patients were randomized into the experimental group, LIBPB, and 7 patients received the standard TIBPB. Subject demographic information is summarized in Table 2.
Some thought was given to the potential increased risk of pneumothorax that may result from low brachial plexus blockade. Pneumothorax would be a devastating and difficult to treat complication in this population. There is no data for the incidence of pneumothorax during low brachial plexus blocks.

However, the most feared complication of a supraclavicular block is pneumothorax, with incidence as high as 6.1% reported during the 1960’s [14]. However, recent literature indicates that the use of ultrasound guidance by an experienced provider substantially reduces the risk of clinically significant pneumothorax during supraclavicular blockade to 0.06% [17], demonstrating further similarities in terms of safety between the two blocks.

The LIBPB and TIBPB groups were also otherwise similar in terms of their post-operative course. Post-operative pain scores and pain medication requirements were similar between the two groups. Neither group required supplemental oxygen in the PACU, other than routine brief use of nasal cannula immediately post-operatively. There were no respiratory complications or unplanned admissions in either group. Length of time in the PACU was not prolonged.

Our study was limited by a small sample size. After enrollment of 15 patients, the study was terminated due to lack of statistically significant reduction in lung function between the two groups. In addition, several of the patients found post-block use of the incentive spirometer to be distressing when they were unable to achieve pre-block sustained maximal inspiration volumes. Continuation of the study was found to be unethical due to risk of patient discomfort without evidence of respiratory benefit in the LIBPB group.

In conclusion, low-modified interscalene brachial plexus blockade in morbidly obese patients provides no respiratory benefit. Moving the location of brachial plexus blockade to lower in the neck has been described as a strategy to avoid phrenic nerve blockade; however, our group found no statistically significant evidence to support this claim. Although use of interscalene peripheral nerve blocks in these patients uniformly caused hemidiaphragmatic paralysis, the effects of reduction in FVC do not appear to cause clinically significant respiratory complications or increase PACU length of stay. Both low modified and traditional interscalene brachial plexus blockade appear to be safe and provide adequate analgesia in morbidly obese patients. Due to similar safety profiles and pain control, neither seems to be have a distinct advantage over the other. Decision to use either block can be based on ease of performance and patient comfort.

### References


